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ANNUAL VARIABILITY RAINFALL MAPS FOR NEBRASKA

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[University of Nebraska, Lincoln, Nebr., March 1935]

INTRODUCTION

In irrigated areas where the required amount of water for crop production is always available, little attention need be paid locally to precipitation. For this reason the routine of farm management may take on a measure of precision that is seldom possible in areas dependent directly upon rainfall with its uncertainties. There is little, if any, land in Nebraska where crop production is not intimately affected by rainfall variability. Those years with low rainfall are, as a rule, not so favorable to the growth of economic plants as are the years with medium or high rainfall.

Since the element of chance is nearly always a factor that the farmer must consider, he is interested especially in knowing approximately what the chances are. He always wants to reduce the chance elements, and increase the elements of certainty. Since rainfall is a variable element, he is interested in knowing not only when his chances for a given amount are even, or 50–50, but also for what farm operations he may expect the chances for the needed amount of rainfall to be 2 to 1, or 5 to 1, in his favor. If he is acquainted with the relative proportion of the chance elements as far as rainfall is concerned, he may plan accordingly and thus succeed in his farm operations a larger proportion of the time. For instance, if it is known that a certain crop seldom succeeds with an annual rainfall of less than 20 inches, then the farmer wants to know what proportion of the time he may expect the precipitation to be up to or above this minimum. If the past record indicates a ratio of 10 to 1 for the minimum amount of rainfall, he might feel much safer in proceeding with proposed plans than if the chances were only 2 to 1.[1]

THE PURPOSE OF THE STUDY

To the average individual, an isohyetal map of the mean annual rainfall of an area probably indicates approximately the amount of precipitation or more that may be expected 50 percent of the time; this view, however, is in error. In reality the rainfall more often falls below the mean than above it. For this reason, the mean as a measure of central tendency is not as satisfactory as the median. The mean annual rainfall for Lincoln, Nebr., calculated from a 56-year record, is 27.82 inches. During this period the annual precipitation has been above the mean 24 times and below 32 times. The median rainfall for Lincoln is 26.50 inches and, of course, 28 times above and 28 times below this amount. To anyone who is interested in the dependability of rainfall, it is at once apparent that the median of 26.50 inches, or 1.32 inches less than the mean, represents the amount that has actually fallen 50 percent or more of the time, or 50 percent or less of the time. When the 56 years of precipitation at Lincoln are arranged in a volume sequence it is a simple matter to find the amount of rainfall such that this amount or more has fallen any desired percentage of the time.

The purpose of this study is to construct a series of rainfall maps for Nebraska on the isohyets of which is indicated the amount of rainfall or more that has fallen 20, 40, 50, 60, and 80 percent of the time, respectively (figures 1, 2, 3). The data basic to the series are the actual amounts of precipitation received year by year for each of the stations within the State where the record has been kept. In only 7 of the 109 stations is the record shorter than 20 years. The average period of observation is 37 years.

RAINFALL VARIABILITY

If the record for each of the stations ran 100 years the obtained median would be nearer the true median. Were a record of 1,000 years available the obtained median and percentile amounts would be still nearer the true ones. Since long-time records are not available, the obtained medians and percentile amounts are assumed to approximate the true figures. It is on this assumption that the data are statistically treated for the construction of the annual variability series of isohyetal maps explained in this paper.

Rainfall variability is usually expressed in terms of departure from the normal (mean). However, the median annual rainfall is lower than the mean at 96 of the 109 stations in Nebraska—averaging 1.08 inches below for the 109 stations. At 13 stations out of the 109 the median is higher than the mean—averaging 0.43 inches above for the 13 stations. For the 109 stations the medians average 0.90 inches below the mean. For the purposes of this study, therefore, the variability is expressed in percentile amounts. Thus, for Lincoln with a 56-year record, 34.17 inches or more of precipitation have fallen 20 percent of the time, 28.05 inches or more 60 percent of the time, and 22.28 inches or more 80 percent of the time (table 1). Corresponding data from 109 stations in Nebraska were used in the construction of the annual variability series of isohyetal maps (figures 1, 2, and 3).

[1] Blair, T. A., *Partial Correlation Applied to Dakota Data on Weather and Wheat Yield*, MONTHLY WEATHER REVIEW, February 1918; *Rainfall and Spring Wheat*, MONTHLY WEATHER REVIEW, October 1913.

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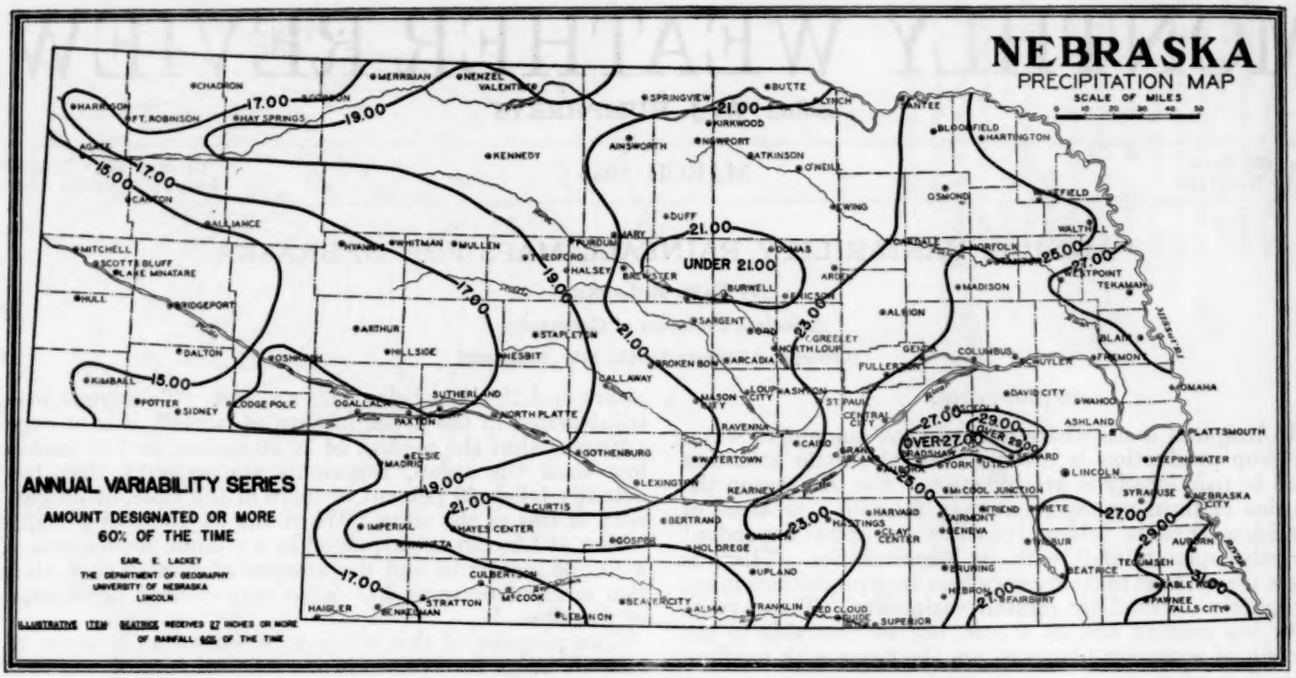

NEBRASKA
PRECIPITATION MAP
SCALE OF MILES
0 10 20 30 40 50
ANNUAL VARIABILITY SERIES
AMOUNT DESIGNATED OR MORE
60% OF THE TIME
EARL E. LACKEY
THE DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF NEBRASKA
LINCOLN
ILLUSTRATIVE ITEM BEATRICE RECEIVES 27 INCHES OR MORE OF RAINFALL 60% OF THE TIME
UNDER 21.00
OVER 27.00
OVER 29.00

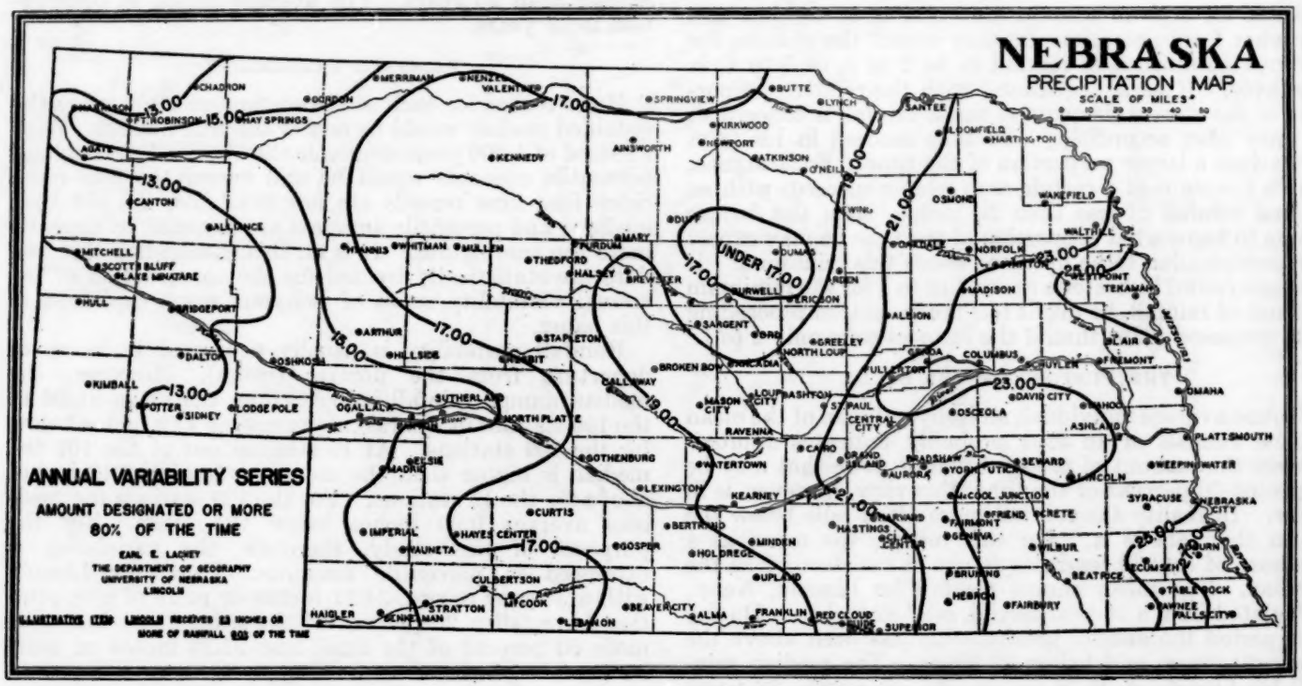
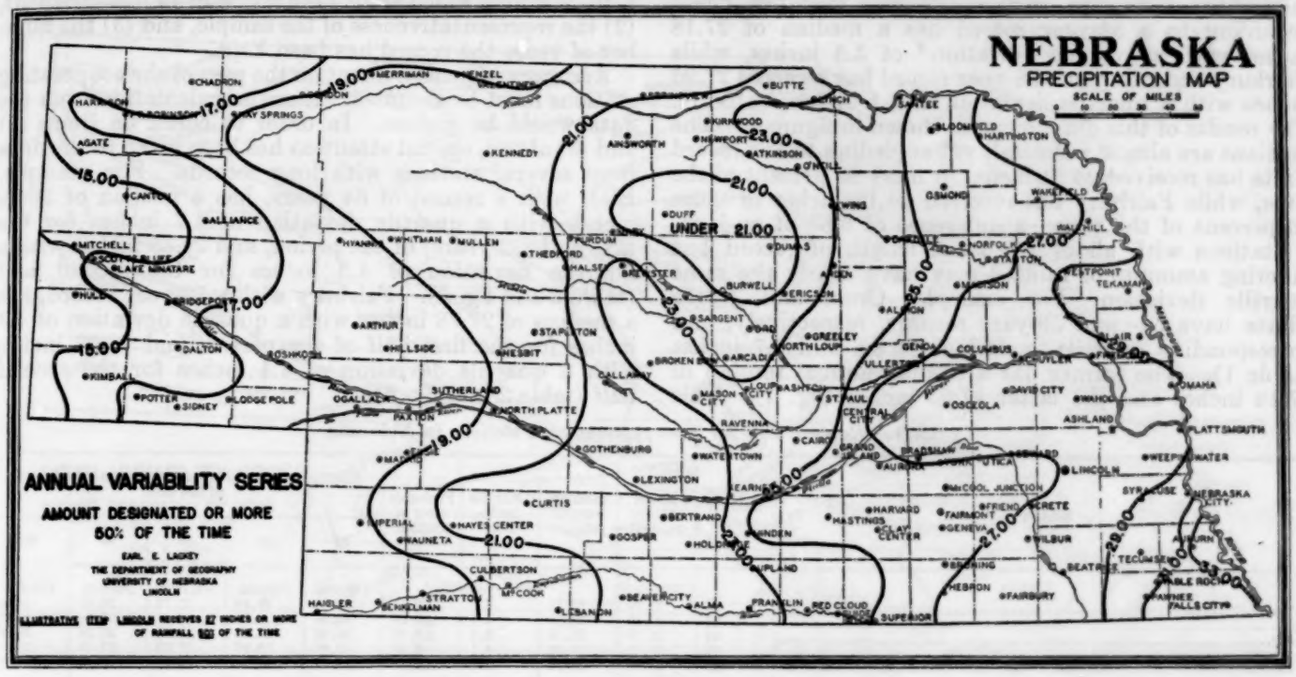

NEBRASKA
PRECIPITATION MAP
SCALE OF MILES
0 10 20 30 40 50
ANNUAL VARIABILITY SERIES
AMOUNT DESIGNATED OR MORE
80% OF THE TIME
EARL E. LACKEY
THE DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF NEBRASKA
LINCOLN
ILLUSTRATIVE ITEM LINCOLN RECEIVES 23 INCHES OR MORE OF RAINFALL 80% OF THE TIME
UNDER 17.00

FIGURE 1.


NEBRASKA
PRECIPITATION MAP
SCALE OF MILES
UNDER 21.00
ANNUAL VARIABILITY SERIES
AMOUNT DESIGNATED OR MORE
50% OF THE TIME
EARL E. LACKEY
THE DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF NEBRASKA
LINCOLN

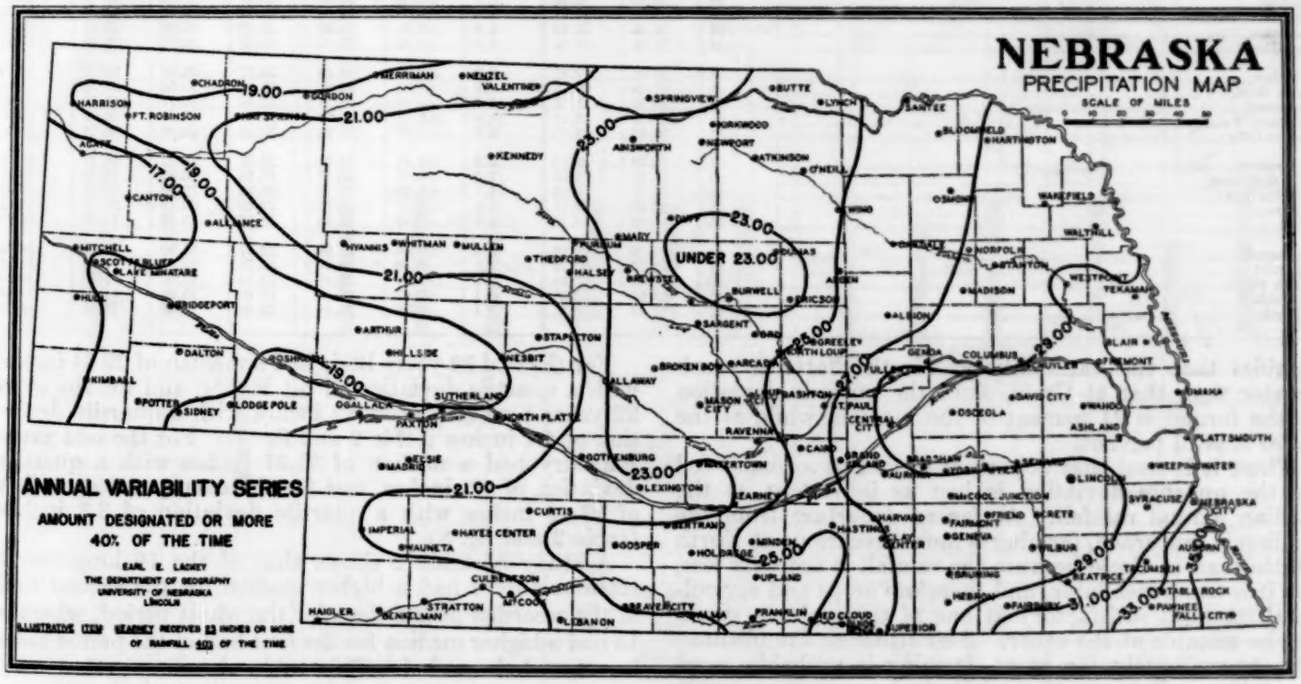

NEBRASKA
PRECIPITATION MAP
SCALE OF MILES
UNDER 23.00
ANNUAL VARIABILITY SERIES
AMOUNT DESIGNATED OR MORE
40% OF THE TIME
EARL E. LACKEY
THE DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF NEBRASKA
LINCOLN

FIGURE 2.

DIFFERENCES IN VARIABILITY

Stations with practically the same median rainfall, and approximately the same number of yearly records, may differ widely in variability. For example, Crete according to a 54-year record has a median of 27.18 inches with a quartile deviation[2] of 3.6 inches, while Fairbury according to a 58-year record has received 27.96 inches with a quartile deviation of 4.1 inches (table 1). The results of this difference are shown in figure 4. The medians are almost identical, yet according to the record Crete has received 23.24 inches or more 80 percent of the time, while Fairbury has received 24.13 inches or more 80 percent of the time—a difference of 0.89 of an inch.

Stations with about the same length of record but differing amounts of rainfall may have nearly the same quartile deviation. For example, Crete and North Platte have 54- and 59-year records, respectively, and corresponding quartile deviations of 3.6 and 3.7 inches (table 1). The former has a median annual rainfall of 27.18 inches and the latter 17.95 inches (fig. 4). This signifies that the variability at North Platte is much greater than that at Crete, since the quartile deviation at the former is 21 percent of the median, while at the latter it is 13 percent.

Thus, it is seen that departure or spread as expressed by the quartile deviation is just as important as the median annual rainfall. As far as departure from the median is concerned, farming is more precarious at North Platte than at Crete because the rainfall is not only less, but it is less dependable, and therefore crops and agricultural methods satisfactory at one of these places would not be suitable at the other. And although the medians are approximately the same, farming is probably more precarious at Fairbury than at Crete, because the quartile deviation at the former is greater than that at the latter.[3]

THE RELIABILITY OF THE RECORD

The reliability of the basic data for the annual variability series of isohyetal maps depends upon several factors among which are (1) the accuracy of measurement, (2) the representativeness of the sample, and (3) the number of years the record has been kept.

Accuracy of measurement on the part of the cooperating stations must be assumed, otherwise calculation from the data would be useless. In order to check on items (2) and (3) above, special attention has been given to the data from several stations with long records. For example, Blair with a record of 64 years, has a median of 30.59 inches with a quartile deviation of 4.7 inches for the first half (32 years) of the period, and 29.35 inches with a quartile deviation of 4.3 inches for the second half (table 2 and fig. 5). Fairbury with a 58-year record, has a median of 27.78 inches with a quartile deviation of 4.3 inches for the first half of the period, and 28.08 inches with a quartile deviation of 4.4 inches for the second half (table 2 and fig. 6).

TABLE 1.—*Rainfall data for some representative stations in Nebraska*

Station	Years in record	Mean annual rainfall	Median annual rainfall	Quartile deviation	Probable error of median	Amount of rainfall or more in given percentages of the time				
						20	40	50	60	80
						Percent	*Percent*	*Percent*	*Percent*	*Percent*
Ashland	50	27.71	27.73	4.8	±0.87	33.34	29.42	27.73	25.11	21.93
Blair	64	29.51	29.81	4.4	±0.69	33.91	30.83	29.81	27.34	24.18
Crete	54	28.19	27.18	3.6	±0.62	33.42	28.19	27.18	26.24	23.24
Fairbury	58	29.35	27.96	4.1	±0.89	34.41	30.90	27.96	27.23	24.13
Franklin	45	23.33	21.74	4.1	±0.76	28.54	23.36	21.74	20.49	18.66
Genoa	58	26.59	26.20	4.0	±0.66	31.72	27.57	26.20	24.79	22.54
Hebron	49	27.59	26.95	4.4	±0.79	33.30	28.62	26.95	24.59	21.45
Lincoln	56	27.82	26.50	5.4	±0.90	34.17	28.05	26.50	25.68	22.28
Minden	56	27.39	25.65	6.4	±1.06	34.76	28.56	25.65	23.37	19.30
Nebraska City	54	31.25	29.50	4.6	±0.79	35.36	31.76	29.50	28.53	24.72
North Loup	45	24.46	23.05	3.9	±0.73	28.98	25.92	23.05	22.33	19.90
Oakdale	45	24.83	23.86	3.7	±0.69	30.91	25.78	23.86	22.73	20.84
Omaha	68	29.04	27.07	4.9	±0.75	34.98	29.54	27.07	25.73	21.64
Ravenna	55	24.65	24.08	3.6	±0.61	28.68	25.58	24.08	22.07	19.51
Red Cloud	45	23.84	23.62	5.1	±0.95	31.14	24.83	23.62	22.28	18.17
Syracuse	51	29.53	29.02	5.0	±0.88	34.63	29.71	29.02	26.77	23.62
Table Rock	45	31.08	29.55	4.8	±0.90	35.81	31.66	29.55	27.50	25.26
Tecumseh	52	30.93	30.71	4.0	±0.69	36.78	32.40	30.71	29.35	25.28
Weeping Water	55	29.57	27.17	4.8	±0.81	35.80	30.66	27.17	26.82	23.92
Beaver City	52	22.65	22.26	3.7	±0.64	27.91	23.94	22.26	20.04	17.95
Culbertson	46	19.98	19.42	2.2	±0.40	22.91	20.03	19.42	18.17	15.61
Fort Robinson	50	16.98	16.83	2.3	±0.41	19.63	17.68	16.83	15.18	12.22
Hay Springs	48	20.31	19.89	4.1	±0.76	25.16	21.95	19.89	18.69	15.98
Holdrege	45	23.65	22.11	3.9	±0.74	28.78	22.30	22.11	21.43	18.52
Kimball	45	16.23	16.10	2.6	±0.49	19.76	17.56	16.10	14.93	12.45
Lexington	44	22.50	21.99	3.5	±0.66	27.07	22.97	21.99	19.92	18.51
Newport	44	22.77	22.72	3.1	±0.59	26.37	23.71	22.72	21.29	18.67
North Platte	59	18.35	17.95	3.7	±0.59	22.47	19.10	17.95	17.12	13.19
Scottsbluff	46	15.95	15.14	3.1	±0.55	20.16	17.00	15.14	14.56	11.66
Valentine	46	19.34	18.27	3.1	±0.58	22.64	19.68	18.27	17.76	15.64

For the odd 32 years Blair had a median of 29.84 inches with a quartile deviation of 5.1 inches, and for the even 32 years a median of 29.82 inches with a quartile deviation of 4.1 inches (table 2 and fig. 7). For the odd years Fairbury had a median of 31.37 inches with a quartile deviation of 4.8 inches, and for the even years a median of 27.49 inches with a quartile deviation of 3.3 inches (table 2 and fig. 8).

A study of table 2 shows that of the 19 long-record stations only 4 had a higher median for the second half of the recorded period than for the whole period, whereas 15 had a higher median for the first half of the period than for the whole period. This table also shows that only 4 of the stations had a higher quartile deviation for the second half of the recorded period than for the whole period, whereas, during the first half of the recorded period 12 stations had a higher quartile deviation than for the whole period.

[2] Quartile deviation (Q) is one-half the difference between the 75-percentile and the 25-percentile points in the given distribution.

[3] The above conclusions, of course, deal only with one of many variables, and therefore do not take into account such factors as seasonal distribution of rainfall, wind velocities, temperatures, humidity, and soil conditions.

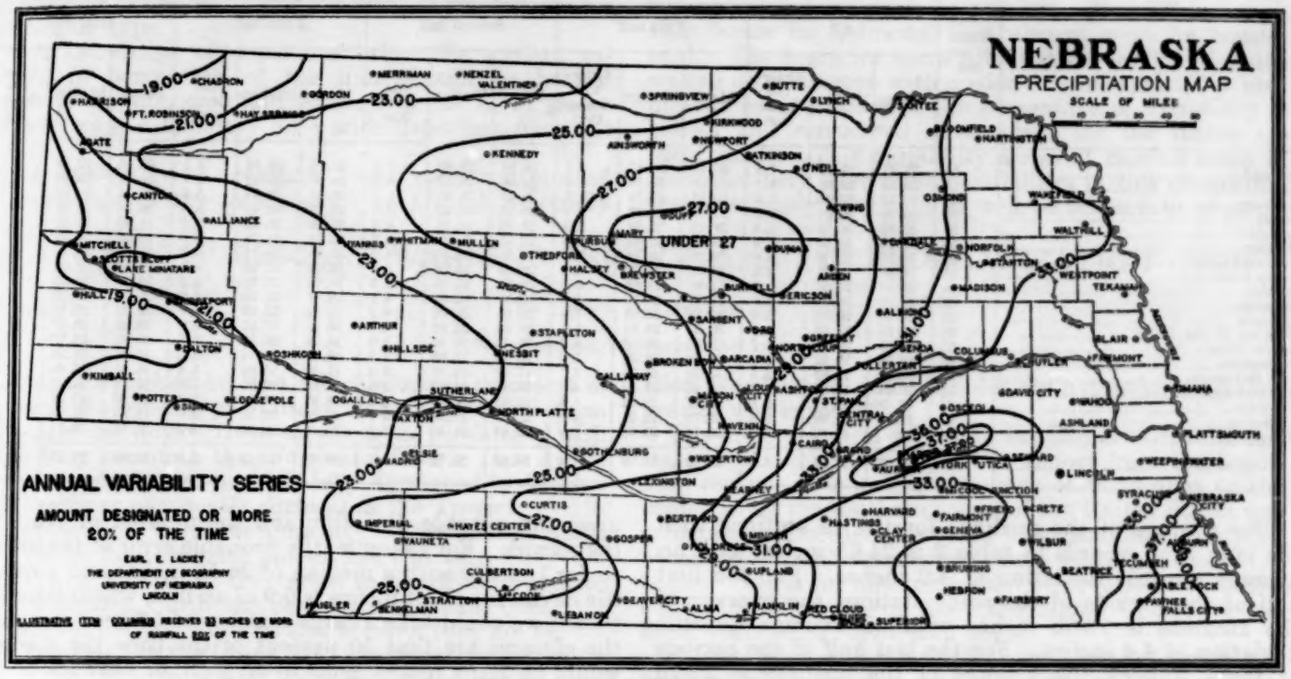


FIGURE 3.

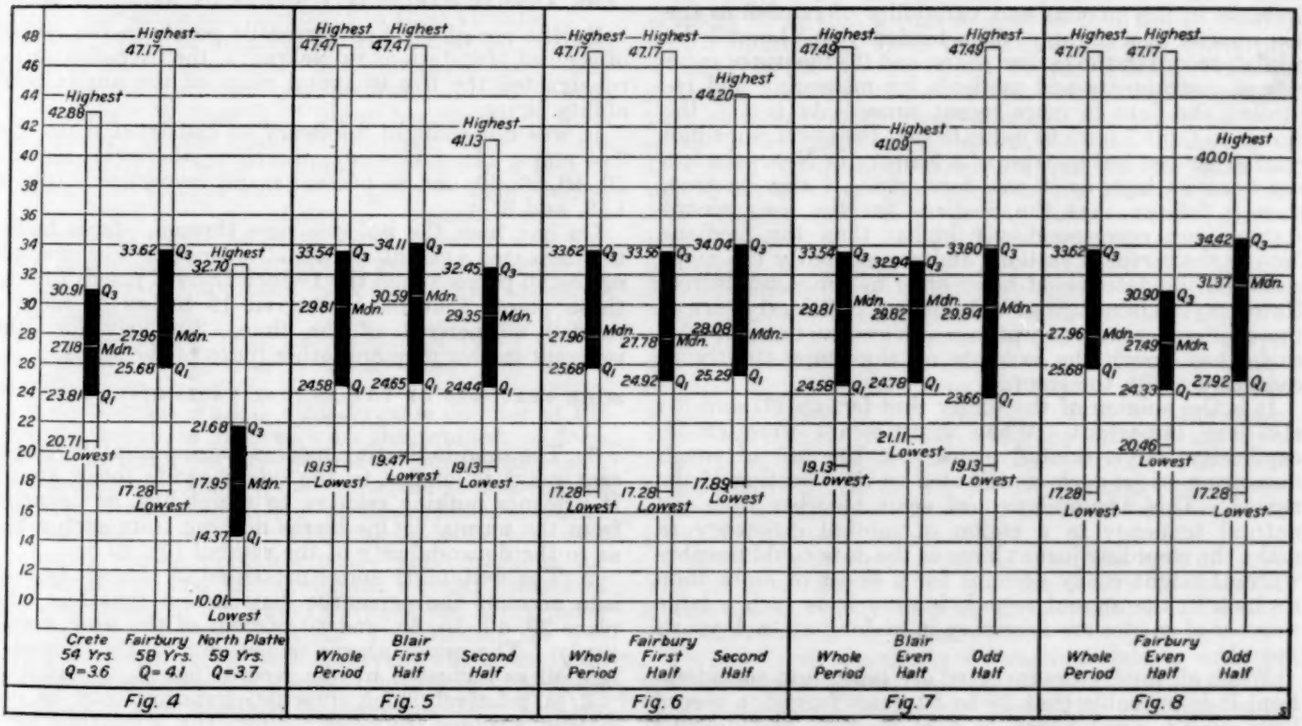


Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8

TABLE 2

Station	Years in record	Portion of record included														
		All			First half			Second half			Even half			Odd half		
		Mean	Median	Quartile deviation	Mean	Median	Quartile deviation	Mean	Median	Quartile deviation	Mean	Median	Quartile deviation	Mean	Median	Quartile deviation
Ashland	50	27.71	27.73	4.8	30.45	30.87	4.3	24.91	23.89	3.9	28.10	26.75	4.5	27.46	27.85	4.9
Blair	64	29.51	29.81	4.4	30.01	30.59	4.7	29.08	29.35	4.3	29.54	29.82	4.1	29.55	29.84	5.1
Fairbury	58	29.35	27.96	5.6	29.17	27.78	4.3	29.42	28.08	4.4	29.45	27.49	3.3	29.14	31.37	4.8
Genoa	58	26.59	26.20	4.0	27.51	27.56	4.2	26.36	25.25	3.8	27.13	26.43	3.8	26.74	25.25	3.8
Lincoln	56	27.82	26.50	5.4	28.05	27.91	5.9	27.70	26.21	4.5	27.60	27.32	5.2	27.93	25.95	5.9
Minden	56	27.39	25.65	6.4	32.22	32.51	5.6	22.56	21.20	2.7	29.15	24.78	6.0	25.62	26.92	7.7
Nebraska City	54	31.25	29.50	4.6	30.96	29.19	5.0	31.56	29.50	4.4	32.90	28.71	4.2	29.60	30.72	4.6
North Loup	55	24.46	23.05	3.9	23.87	24.77	4.4	25.03	23.25	3.6	24.99	22.42	4.4	23.88	23.66	3.1
Omaha	68	29.04	27.07	4.9	31.97	28.98	6.5	25.99	25.83	3.8	36.63	26.99	4.3	28.66	26.89	5.5
Ravenna	55	24.65	24.08	3.6	25.87	25.58	3.4	23.39	22.42	3.8	23.66	23.76	3.9	25.60	24.26	5.2
Syracuse	52	29.53	29.02	5.0	29.39	29.03	4.4	29.65	29.04	4.2	29.82	27.60	3.8	29.22	29.18	4.9
Weeping Water	55	29.57	27.17	4.8	30.23	28.54	5.1	28.90	26.87	4.4	30.83	27.01	4.9	28.30	30.47	5.1
Beaver City	52	22.65	22.26	3.7	23.86	24.10	4.9	21.46	20.46	2.9	24.24	20.45	3.7	21.08	23.77	4.6
Culbertson	46	19.98	19.42	2.2	18.88	18.26	1.6	20.89	17.89	2.6	20.93	19.14	2.6	18.05	19.80	3.1
Fort Robinson	50	16.98	16.83	2.3	16.30	16.76	2.7	17.07	16.96	3.8	17.69	15.80	3.6	16.46	17.48	2.8
Hay Springs	52	20.31	19.89	4.1	19.47	20.59	4.2	21.12	19.55	3.8	20.84	19.89	2.0	19.75	20.84	4.4
Holdrege	44	23.65	22.11	3.9	24.87	22.72	4.4	22.43	21.40	3.2	24.93	21.36	3.3	22.36	22.37	2.8
Lexington	44	22.50	21.99	3.5	22.74	22.01	4.5	22.26	21.59	3.9	23.36	22.23	4.0	21.29	21.73	3.9
Newport	44	22.77	22.72	3.1	23.13	23.73	2.9	22.43	21.16	2.5	21.19	22.21	2.5	21.67	23.71	3.0
Averages	53	25.55	24.65	4.2	26.30	25.90	4.4	24.83	23.70	3.7	26.41	24.22	3.9	24.82	25.32	4.5

The average of the medians for the 19 stations with the long time records in table 2 is 24.65 inches with an average quartile deviation of 4.2 inches. For the first half of the periods of the same stations the average of the medians is 25.90 inches with an average quartile deviation of 4.4 inches. For the last half of the periods of these stations the average of the medians is 23.70 inches with an average quartile deviation of 3.7 inches.

Several factors may enter into the explanation of this situation among which are (1) the possibility of an actual decrease in the amount and variability of rainfall in the last quarter of a century, (2) a tendency to "boost" the rainfall record in the earlier years, and (3) the use of more refined instruments and methods for measuring and recording the data in more recent times. As to (1), the figures in table 2 seem to indicate that the average median rainfall for the last quarter of a century in Nebraska has not been as high as it was formerly. If this be true, then it follows that the medians for the long record stations run correspondingly higher than the medians for the short record stations and consequently the maps based on the data would be in error in the same degree. However, the investigator did not feel sufficiently sure of these differences to attempt to set up a correction formula, so he has drawn the isohyets on the maps strictly in conformity with the records.

It is the opinion of the writer that factors (2) and (3) also are important. When instruments were crude, capillarity, large rainfall gages and the use of rough measuring sticks each contributed to the boosting of the record. This accumulation of error together with the natural tendency in a region of rainfall deficiency to make the recording just as large as the data could possibly warrant might easily account for a boost of more than an inch in the annual record, inasmuch as such a large number of entries are necessary in making up each year's record.

When all the factors involved are taken into consideration, it is probable that 25 to 30 years furnish a record long enough upon which to base medians and quartile deviations with a fair degree of reliability.

A statistical measure of reliability of a median is the probable error of the median.[4] This measure depends upon the quartile deviation and the number of years in the record. For example, the probable error of the median for Lincoln with a median of 26.50 inches and a quartile deviation of 5.4 inches is 0.9 of an inch which signifies that if we could take a large number of 56-year samples, the chances are that 50 percent of the time the median would be 26.50 inches ± 0.9 of an inch, or between 25.60 inches and 27.40 inches. Table 1 shows the probable error of the median for representative stations.

[4] Garrett, Statistics in Education, pp. 126–127, Longmans, Green and Co., New York, 926.

THE ANNUAL VARIABILITY SERIES OF RAINFALL MAPS

By the use of the five percentile points in the records of each of 109 stations in Nebraska, the investigator has constructed the five isohyetal maps of the annual variability series.

It was not thought necessary to construct more than five maps. In this study, therefore, the series includes 20, 40, 50, 60, and 80 percent maps, respectively (figures 1, 2, and 3).

On any map the isohyets pass through places having the indicated amount of rainfall or more. For example, on the 80 percent map the 19-inch isohyet passes through those places that have received 19 inches or more of rainfall 80 percent of the time. Similarly for other isohyets on this map and other maps of the series.

SOME FEATURES OF THE ANNUAL VARIABILITY SERIES OF RAINFALL MAPS

1. The map indicating median annual rainfall (50 percent map) is similar to the one showing mean annual. It presents nothing relative to variability, or departure from the normal. One learns nothing from such a map as to the dependability of the rainfall (fig. 2).

2. The variability series presented in this study takes into account the percentile distribution that has taken place 20, 40, 50, 60, and 80 percent of the time, respectively. The series shows something of the spread of rainfall as indicated by the record (figs. 1, 2, and 3).

3. A relatively high quartile deviation may be considered perilous, especially when the departure below the median is great. In such cases a deficiency in rainfall for the usual crops might be expected frequently. This holds true especially in subhumid and semiarid regions. Under such conditions we customarily say the rainfall is not dependable.

4. A relatively low quartile deviation is usually considered favorable. A small departure below median probably would not often be disastrous. In areas where the quartile deviation is low we say the rainfall is of a dependable type.

5. A knowledge of departure below the median expressed in percentage of the time should be helpful especially in subhumid and semiarid areas, or in places where there is a tendency for a wide departure from the median.

6. A knowledge of departure above median expressed in percentage of the time should be helpful especially where superabundance of rainfall may be harmful to crops or produce floods.

7. Intelligent long-time planning always takes into account as many factors as possible. Rainfall is a variable factor in Nebraska that always must be considered. The more we know about it the better planning we can do. An area with a wide rainfall variability may present fewer hazards if the percentage of variability is known and considered when plans for the future are being made. This variability series of rainfall maps of Nebraska may offer some possibilities in this connection that previously could not so well be taken into account.

THE HURRICANE WARNING SERVICE AND ITS REORGANIZATION

By EDGAR B. CALVERT

[Weather Bureau, Washington, April 1935]

Tropical cyclones are the meteorological monsters of the sea. No other type of ocean storm approaches them in violence and destructiveness, nor in the persistency with which they maintain their form and force. It is a rare thing for one of them that has fully developed to dissolve and disappear over water surfaces in the Tropics. With few exceptions they continue as violent storms until they strike land or pass out of the tropics. They are called hurricanes when they occur in the Atlantic Ocean, Gulf of Mexico, Caribbean Sea, and the Pacific Ocean off the coast of Central America and Mexico; they are known as "typhoons" in the China Sea; "baguios" in the water area of the Philippines and "cyclones" in the Bay of Bengal and other portions of the Indian Ocean. By whatever name they are known and wherever they occur they strike terror into the hearts of seamen and of people who reside along the low-lying shores subject to their visitation.

No one person or organization can surely be credited with being the first to engage in a systematic forecasting program for the purpose of giving warning of the approach of hurricanes. William Reid began his studies of them when on duty on the island of Barbados in 1831. His work published in 1838 is still held in esteem as a book of reference. He studied hurricanes, plotted their courses, and formulated his "law of storms", including rules for mariners to maneuver so as to avoid their centers; and in 1847 he established the earliest system of displaying warnings when the approach of a storm was indicated by the barometer.

The credit for the next warnings is probably due to Father Benito Viñes, who for many years was associated with Belen College at Habana, Cuba. It is known that in 1870, when Father Viñes became director of the college, he began to grapple with the problem of forewarning the people of the advent of hurricanes which threatened them. Before that time the inhabitants of Cuba were accustomed to hear of these phenomena only upon their near approach. This was the same year that the United States Congress made appropriations for organizing a national meteorological service, control of which was vested in the Signal Corps of the Army (later transferred to the Agricultural Department as the Weather Bureau). The Signal Service was scarcely in position to issue hurricane warnings until August 6, 1873. On that date arrangements for securing daily weather reports by cable from Cuba and other islands of the West Indies went into effect with receipt of observations from Habana. Daily reports from Kingston began September 18, and from Santiago de Cuba, on September 29 of the same year. Plans for obtaining reports from Puerto Rico, Guadeloupe, and Barbados did not materialize that year as was expected.

The meteorological service of the Signal Corps did not start functioning until 1870, but almost from the beginning the need for issuing warnings of hurricanes to the people along the southern coasts of the United States was recognized; also that this could be accomplished only by obtaining current observations from islands in the West Indies. Plans for obtaining such observations were discussed in the reports of the Chief Signal Officer for the fiscal years 1872, 1873, and 1874.

Father Viñes had nearly 3 years' start on the Signal Service in organizing his hurricane warning service. According to one of his commentators (Rev. Walter M. Drum, S. J.), the earliest authenticated date on which he issued a warning was September 11, 1875, but it seems likely that he did so prior to that time. There, too, is uncertainty as to the date of the first hurricane warning issued by the Signal Corps. Father Viñes is generally conceded to be the first meteorologist to forecast hurricanes from observations of the upper as well as the lower clouds; also, he was the first to announce that both the place of formation and the direction of movement of hurricanes change as the season advances. The August 1873 issue of the MONTHLY WEATHER REVIEW refers to a forecast issued on August 23, 1873, of stormy weather for the New England and Middle Atlantic coasts "with cautionary signals at Cape May, New York, and New London." This article contains a statement to the effect that the storm was of tropical origin, that it was by far the worst one since the establishment of the Signal Corps and that it "did not occur within the limits of our stations." It is a safe deduction that August 23, 1873, was the date of the first warning issued in connection with a storm of tropical origin but it would not be proper to claim that it was a hurricane warning because the storm was extratropical when the warnings were put out.

Father Viñes is justly placed in the front rank of those who have contributed to our knowledge of tropical storms and have been untiring in their efforts to develop means for forecasting them.

Father Viñes' hurricane forecasting studies were in four directions: First, to find some sign or group of signs that would invariably prove the existence of a cyclone while it was yet at a great distance from the observer; second, to get bearings in regard to the whirlwind, i. e., to determine what part of the horizon it was coming from; third, to locate the trajectory or curve along which the cyclone would move, and to do this in

time for the observer to betake himself to a safe distance from that fatal curve; fourth, to determine the distance of the hurricane from the observer, its intensity, area, and velocity.

A serious setback in the development of the hurricane warning service occurred in 1876 because of discontinuance of observations from the West Indies, due to lack of funds for cabling, but this difficulty was partially overcome by the generosity of the cable companies in granting reduced rates of one-third to one-half of commercial rates.

In 1881 the reports from the West Indies again were suspended partly because of lack of funds but principally because of "doubt being thrown on the legality of spending any part of the appropriations in maintaining a station outside of the limits of the United States." This difficulty appears to have been removed before the next season began. At that time reports were being received from six West Indian localities, namely, Barbados, Guadeloupe, Habana, Kingston, Santiago de Cuba and St. Thomas. In 1888 or 1889 other reports, from Puerto Rico, Santa Cruz, and Antigua, were secured through the newly organized Cuban Meteorological Service which was established January 15, 1889, under the direction of the Naval Observatory of Cuba. From that time onward until the outbreak of the Spanish-American War the records do not disclose any material change in the general operating plans of the hurricane warning service.

In 1898 there was what may be termed the first reorganization of the hurricane warning service. It was due to the Spanish-American War. Prior to that time warnings had been confined to our own coastal areas, although there was courtesy exchange of hurricane information between the Weather Bureau and the Cuban Meteorological Service and Belen College.

Since 1873 observers at West Indian points had been local residents. They were paid for taking the observations but were not subject to any official control by our Government. When war was declared in 1898, it was recognized at once that the hurricane warning service on the old basis would be wholly inadequate to protect the large fleet of naval craft, transports and United States merchantmen operating in the waters subject to hurricane visitations. Accordingly, a bill was drafted and submitted to Congress on June 16, 1898, authorizing the Weather Bureau to establish and operate observing stations throughout the West Indies and along the shores of the Caribbean Sea. The act making appropriations for the service was not approved until July 7, 1898. Permission had to be obtained from various governments for placing trained observers and citizens of the United States at places from which observations were desired. It was obvious that only those whose loyalty and efficiency were beyond question could be given responsibility in such an important undertaking. Much of this preliminary work was done before the appropriation act was passed on July 7, 1898. By vigorous action the first party was started on July 22, 1898, and before the middle of August trained observers of the Weather Bureau had opened stations at Kingston, Jamaica; Port of Spain, Trinidad; Willemstad, Curacao; Santo Domingo, Santo Domingo; and at Santiago de Cuba. Before the middle of September additional stations were operating at Basse-Terre, St. Kitts; and Bridgetown, Barbados. The Weather Bureau forecasting center in the West Indies was located at Kingston, Jamaica.

The war soon was over; in fact, before there was opportunity to issue warnings to our combatant fleet. Nevertheless, there never was question as to the wisdom of the action to provide means for guarding our ships against hurricanes, one of which unannounced might have caused enormous damage. Notwithstanding the cessation of hostilities it was decided to complete the original organization plan. Stations were established at Roseau, Dominica; at San Juan (soon after Puerto Rico came under United States control) and at Colon. Original intentions to place stations at St. Thomas and Barranquilla were abandoned and the station at Colon was closed early in 1899. Headquarters of the forecasting service was transferred to Habana on February 1, 1899. At the same time plans were perfected for giving all parts of the West Indies and ships of all nationalities the benefit of the hurricane warning service of the Weather Bureau. This responsibility has international recognition to this day.

Within a year after the declaration of peace on December 12, 1898, observers began to be withdrawn from the West Indian stations as fast as capable local persons could be trained and qualified to take the observations. In 1902, at the termination of the American occupation, the hurricane forecasting work for the West Indies was transferred from Habana to Washington. All Weather Bureau employees were withdrawn except one who remained for the purpose of completing the substitution of local observers for those sent from the United States. A forecast center for the issuing of hurricane warnings and advices for Puerto Rico and contiguous areas was established at San Juan on June 1, 1919.

Steady improvements were made in the efficiency of the service after the Spanish War. The largest factor in this improvement has been the development of the radio. It has added tremendously to the field of observation. Far greater dependence now is placed on ship reports than on observations from island stations. Ships make regular contributions of two observations a day and additional ones when needed. Last year more than 21,000 observations were received from ships in the southern portions of the North Atlantic, the Gulf of Mexico and the Caribbean Sea during the 6 months which constitute what is known as the hurricane season.

A third epochal change in the hurricane warning service will occur on July 1, 1935. Changes as contemplated on that date are made possible by an item of $80,000 contained in the Weather Bureau portion of the agricultural appropriation bill for the next fiscal year.

Since the beginning of the hurricane warning service in 1873, warnings and advices concerning tropical storms have been issued from Washington, except for the short period during the Spanish War when warnings for the West Indies area were issued from Kingston and Habana, and the service rendered at San Juan since 1919. Under the new reorganization effective on July 1, 1935, no warnings of tropical storms will be issued from Washington except for such as have moved north of latitude 35°N. It is believed that more expeditious, satisfactory, and efficient service can be rendered from forecast centers located nearer to the scene of action than is Washington. Strictly speaking, after that date there will be three hurricane warning centers as follows:

San Juan.—Caribbean Sea and islands east of longitude 75°W. and south of latitude 20°N.

New Orleans, La.—That portion of the Gulf of Mexico and its coasts west of longitude 85°W.

Jacksonville, Fla.—Remaining portions of the Atlantic, Caribbean Sea and Gulf of Mexico areas, islands and coasts south of latitude 35°N.

Jacksonville also will be a district forecast center to include the States of North Carolina, South Carolina, Georgia, and the Florida Peninsula. From that center will emanate all daily weather forecasts, warnings of cold waves, frosts, weekly outlooks, etc., for the States named in addition to storm and hurricane warnings. At present all of this work is being done at theWashington forecast center. Jacksonville also will take over from the Washington center twice daily wind and weather forecasts for the coastal and contiguous ocean zones, Hatteras to Jacksonville; Jacksonville to the Florida Straits; the eastern Gulf of Mexico (east of longitude 85°W.) and the Western Caribbean Sea (west of longitude 75°W.)

New Orleans is now a forecast center for extreme northwest Florida, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma and Texas and storm warnings for the Gulf Coast from Apalachicola westward to Brownsville. Its principal additional work to be transferred from the Washington center will be the hurricane service for the area as heretofore described; also daily wind and weather forecasts for the middle Gulf of Mexico (between longitude 85°W. and 90°W., north of the Yucatan Channel) and for the Western Gulf of Mexico (west of longitude 90°W.) will emanate twice daily from New Orleans instead of from Washington.

The reorganization program involves material changes in the collection of observations from ships. Under existing arrangements observations are secured regularly twice a day throughout the year by radio from a limited number of selected ships in the Atlantic, Gulf of Mexico, and Caribbean Sea. These reports are now transmitted only to Washington. On and after July 1, 1935, selected ships routed south of latitude 35°N. will transmit their observations addressed both to Washington and to Jacksonville. The North Atlantic ships will continue to report only to Washington. Another class of ships, known as cooperative, supplies observations only during the hurricane season, June to November, inclusive. Heretofore service from this class of vessel consisted of two observations a day, taken at 0000 and 1200 G.C.T., and containing only the universal group of data (day of week, octant of globe, latitude, longitude, direction of wind, state of weather, wind force, barometric pressure, visibility and temperature). After July 1, and during the period June 16 to November 15, inclusive, they will take 2 additional observations, at 0600 and 1800, G.C.T., making 4 in all. Observations from cooperative ships will contain the universal data group and also a supplemental group (swell, clouds, temperature difference between air and water, ship's course, barometer change, and past weather). Cooperative ship reports will be addressed only to Jacksonville.

A system of direct calls for special observations from ships when a hurricane is in progress was inaugurated in 1934. It proved to be successful and it will be continued in the reorganization program. This plan, briefly stated, is as follows: The southern portion of the Atlantic, the Gulf of Mexico, and the Caribbean Sea is divided into 5° squares which are numbered. When a hurricane is known to be in progress, commercial radio stations at Galveston, Port Arthur, Tampa, West Palm Beach, and Ensenada (Puerto Rico) are informed of the areas (squares) from which special ship reports are desired and the time the observations should be taken. Operators at these stations contact all ships in the specified squares and ask that the observations be radioed to a specified Weather Bureau forecast center. In this way many valuable reports are secured which otherwise would not be available.

Another feature, not strictly new but on a more systematized basis, will be cooperation with the Coast Guard, whereby weather observations, including data on swells and tides, will be obtained from Coast Guard life saving stations. As a rule observations from Coast Guard stations are not needed until the storm has approached within a few hundred miles of the coast. They will be collected by telephone, telegraph, and radio and speedily will be made available to the forecast centers at New Orleans and Jacksonville. In a similar way there will be cooperation with Coast Guard ships both in forwarding observations taken on board and also in collecting observations from other ships. By a like plan reports from Coast Guard stations, from Cape Fear River northward to the Delaware Breakwater, will be secured for the forecasters at Washington.

An incidental but important part of the program will be the exchange of warnings and advices issued at Washington, Jacksonville, and New Orleans so that each may have knowledge of what the others have done and thereby avoid conflict and confusion.

The Weather Bureau maintains storm warning display stations at numerous ports along the coasts affected by hurricanes. A systematic plan for obtaining special weather, tide and swell observations from those places is a part of the program.

At the present time all hurricane warnings and advisories are included in a bulletin specially designed for the use of masters of ships at sea and are broadcast twice daily through the naval radio station (NAA) at Arlington, Va. This bulletin is copied by other naval stations and rebroadcast so that all ships in waters subject to tropical storms are warned. This service will be continued. Warnings issued from San Juan, Jacksonville, and New Orleans will be telegraphed to Washington for inclusion in the bulletin. In addition, a special bulletin containing weather information, forecasts, hurricane warnings, etc., will be broadcast twice daily during the hurricane season and on fixed schedules from the naval radio station at Key West, Fla. It is expected that commercial radio stations will cooperate similarly in the distribution work.

A unique and important feature of the reorganization will be a teletypewriter set-up during the five active hurricane months. This system is designed for speedy collection of observations from life saving and storm warning stations, the distribution of land and ship reports from one forecast center to the other, including intervening first order stations, and immediate dissemination of warnings and advices to the entire coastal area. This teletype circuit will connect the Weather Bureau forecast centers at Jacksonville and New Orleans and its offices at Tampa, Miami, Key West, Pensacola, Mobile, Port Arthur, Houston, Galveston, Corpus Christi, and Brownsville. The teletype circuit will operate 24 hours a day, every day in the week, including Sundays and holidays, and will be used exclusively by the Weather Bureau.

A forecaster will be on duty night and day at Jacksonville and New Orleans and trained observers will be on watch constantly at all the other offices having teletype installations. In this way advantage will be taken of every weather report that has significance, the forecaster will be in continuous touch with the local Weather Bureau officials and through the latter the newspapers and the public will be kept fully and promptly informed.

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CHRONOLOGY

1831. Capt. William Reid began hurricane studies on the island of Barbados.
1838. Reid published his laws of storms.
1847. Reid established display of signals at approach of storms.
1870. Father Benito Viñes became director of Belen College and inaugurated a hurricane-forecasting service, for Cuba.
1870. February 9: United States Congress made appropriations for a national meteorological service.
1873. August 6: Daily reports from Cuba and other West Indies islands first received.
1875. September 11: Father Viñes issued first hurricane warning.
1876. Set-back in development of hurricane-warning service due to discontinuance of reports from West Indies.
1881. West Indian reports again suspended; legality of expenditures outside of United States questioned.
1889. January 1: Meteorological service for Cuba organized under direction of Naval Observatory of Cuba.
1898. First reorganization of hurricane-warning service to protect American fleet during Spanish-American War; bill for providing funds submitted to Congress June 16; approved July 7.
1898. July 25: First observing station opened at Kingston, Jamaica, which was made headquarters of hurricane-warning service.
1899. February 1: Headquarters of forecasting service transferred to Habana.
1902. Forecasting service for hurricanes transferred from Habana.
1902. National Meteorological Service of Cuba established.
1919. June 1: Hurricane-warning center for Puerto Rico established at San Juan.
1935. July 1: Second reorganization of hurricane-warning service; service transferred from Washington to centers at Jacksonville and New Orleans.

EFFECT OF THE ATLANTIC OCEAN ON TEMPERATURES IN EASTERN UNITED STATES AS SHOWN BY TEMPERATURE-WIND ROSES [1]

By KATHARINE B. CLARKE

[5814 Thirty-second Street NW., Washington, D. C., March 1935]

In the preparation of a thesis concerned with some effects of the Atlantic Ocean upon the climate of eastern United States, a study was made of the effectiveness of the ocean in moderating temperatures at various stations. The decrease in temperature ranges along the Atlantic coast is obvious from maps of the average daily range of temperature (figs. 82, 83, and 84, p. 25, *Atlas of American Agriculture*, Pt. II, Climate, Sec. B, Temperature, Sunshine, and Winds, United States Department of Agriculture, Washington, D. C., 1928); there is a very much smaller daily range along the immediate seashore than inland. The Brownsville region, southern tip of Florida, Cape Hatteras and Cape Cod have in spring, summer, and fall the small daily range of 9° to 12° F. A comparison of the highest and the lowest recorded temperatures (fig. 3, p. 7, and fig. 6, p. 8, *Atlas of American Agriculture, loc. cit.*) shows a pronounced moderating effect of the Atlantic Ocean along the coast, but indicates that this does not extend westward beyond the Appalachian Mountains.

To show, by some quantitative and graphical means, the influence of winds from the direction of the Atlantic Ocean upon the temperatures of coastal and inland stations, temperature-wind roses were constructed: Data used for these roses were the 8 a. m. readings of temperature and wind-direction published on the Washington daily weather maps. Seventeen stations in eastern United States were chosen, and data for 20 years (1906–25) for the months of January and July were compiled and averaged. For each station the following data were obtained: (1) Average 8 a. m. temperature; (2) frequency of winds from the cardinal and semicardinal points; (3) average temperatures with winds from each direction; (4) the departure, from the 8 a. m. average temperature, of these average temperatures for each wind-direction.

From this information the roses were constructed, as illustrated by figure 1, the January and July roses for Boston: The center part is a simple frequency wind rose. On the 620 January days, Boston had a northwest wind 149 times and a southeast wind 23 times. At a convenient distance from the center of the rose (the same distance for all directions and for all roses), a point was chosen as a zero from which to plot temperature departures; minus departures were represented inside the zero point, and plus departures outside. A polygon, which is a perfect octagon, connects the zero points and represents the simple average 8 a. m. temperatures for the 620 days. A heavy line connects the points that represent the departures; it forms the temperature-wind rose, a distorted polygon. The amount and kind of distortion represents the effect upon temperature of winds from the different directions; on the Boston January rose, for example, the mean departure with a northwesterly wind is minus 7.7°, and with a southeasterly wind, plus 7.5°.

Unfortunately it is almost impossible to make a correction for the different latitudes from which the winds come; southerly winds usually bring warmer air, and northerly winds colder air. The greatest interest is in winds from easterly directions, as the purpose of the roses is to measure, if possible, marine influence. Local conditions of topography will affect almost every station; Albany, for example, has a very decided minus departure in winter with southeasterly and easterly winds as well as with northeasterly winds, since easterly winds bring colder air from the nearby highlands.

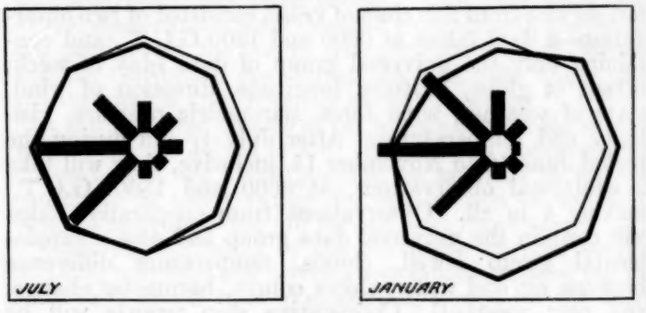


FIGURE 1.

These temperature-wind roses were placed on a map of the eastern United States in their respective positions. Figure 2 shows the roses for January so placed; for purposes of better reproduction, the zero polygons have been changed to broken lines. The distortion of the solid-line polygons indicates that departures from the average are greatest along the New England coast. The roses very clearly show the plus departures with easterly, southeasterly, and even northeasterly winds. This plus departure with an easterly wind in January does not appear at

[1] A part of a thesis submitted to the Faculty of Clark University, Worcester, Mass., June, 1930, in partial fulfillment of the requirements for the degree of master of arts in the department of geography.

inland stations. It is interesting to note the changing shape of the January roses on a line from Cape Hatteras through Charlotte, Chattanooga, and Memphis to Oklahoma City. At Cape Hatteras the polygon is considerably distorted to the south and east, indicating temperatures appreciably above average with southerly and easterly winds. At Memphis there is a pronounced southward and southwestward extension of the polygon, indicating highest temperatures with winds from those directions. A comparison of the lake stations, Buffalo and Chicago, with the Atlantic coastal stations shows that winds from off the Great Lakes bring departures somewhat like those with winds from the Atlantic Ocean.

Figure 3 gives the July temperature-wind roses for all the stations. The solid-line polygons indicate, by their slight distortion, little departure from the average temperature at any wind direction. Greatest distortion occurs along the New England coast. The negative departures when east winds blow is 4°.1 at Eastport, 2°.4 at Portland, 5°.6 at Boston, 1°.6 at Nantucket, 0°.7 at Atlantic City, and 0°.9 at Cape Hatteras. Departures are greatest along the coasts of New England because of the greater contrast between sea and land temperatures, due in turn chiefly to the much cooler sea.

By averaging the departures of southeast, east, and northeast winds (calling this average the "easterly wind temperature"), and taking the difference between this and the average departure of southwest, west, and northwest winds (calling this the "westerly wind temperature"), a numerical measure of the comparative temperatures of easterly versus westerly winds, or, on the Atlantic seaboard, marine versus continental winds, may be obtained. Likewise, by averaging the departures that accompanied the winds from the three northerly directions ("northerly wind temperature"), and subtracting this from the average for the winds of the three southerly directions ("southerly wind temperature"), a numerical measure of temperature with winds from southerly latitudes versus those from northerly latitudes may be obtained. A comparison of the difference between temperatures of easterly versus westerly winds with those of northerly versus southerly winds may be stated in the form of a simple ratio; the numerator has been chosen to represent the difference between easterly and westerly wind temperatures, and the denominator the difference between southerly and northerly wind temperatures.

These computations have been made for each station for January and July and appear in table I. From this table it is evident that during January, at all coastal stations except Atlantic City and Philadelphia, easterly winds are warmer than westerly; but no station away from the immediate coast except Chicago, which has a large body of water to the east, has higher temperatures with easterly than with westerly winds. At every station southerly winds in January bring higher temperatures than northerly winds.

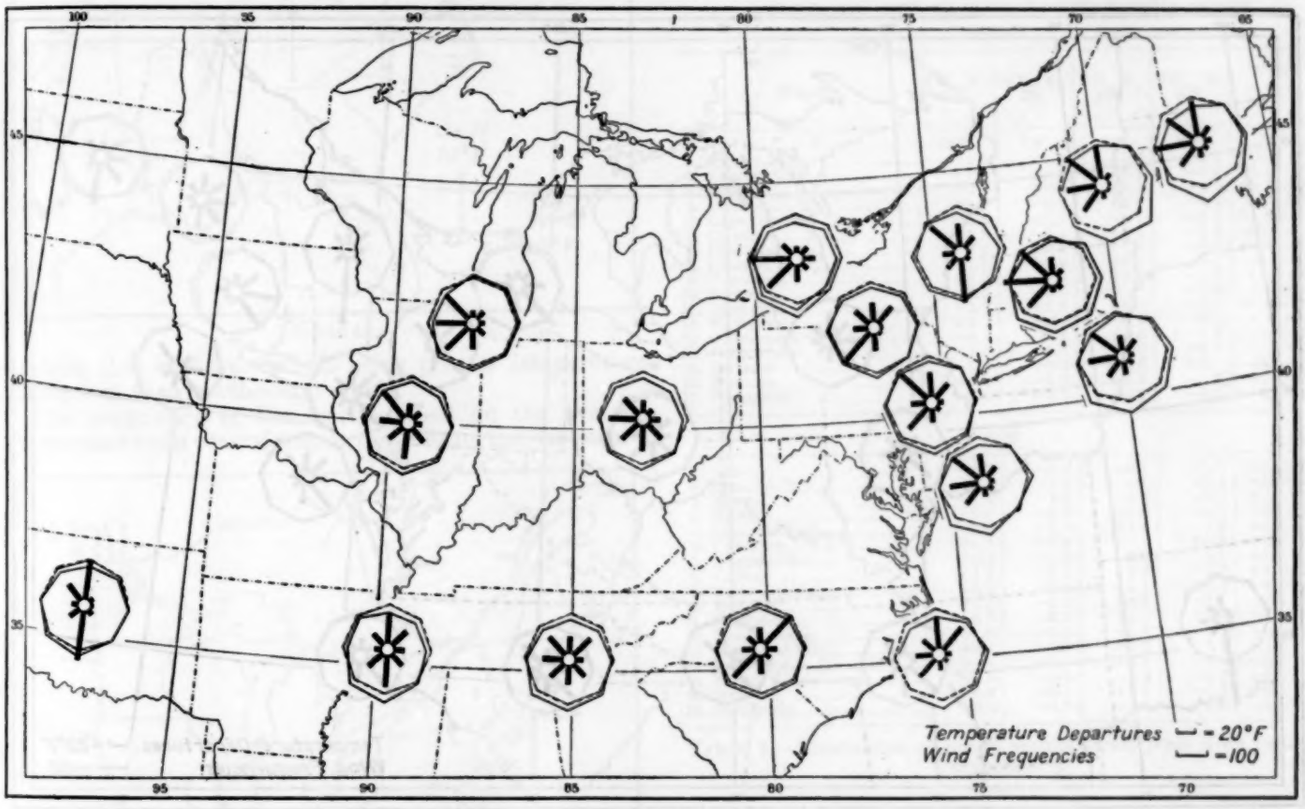


FIGURE 2.

It is somewhat surprising to find that at Boston in January the difference between easterly and westerly wind temperatures is about three-fifths as great as that between northerly and southerly wind temperatures. In other words, easterly winds are no less than three-fifths as effective as southerly winds in bringing higher temperatures. This fraction would be increased if a correction were made for the fact that all easterly winds are not purely marine and all westerly are not purely land winds. If the coast extended indefinitely in a north-south direction, all westerly winds would be from the land, and all easterly winds from the sea; however, in the case of Boston, for example, northeasterly winds may blow over some land surface (Maine), and south-

westerly winds may have passed over some water surface (south of New England). Northeasterly winds at Boston, therefore, are not strictly speaking winds from the sea, and are presumably cooler in winter and warmer in summer than they would be if they did not blow over land as well as water before reaching Boston. Likewise, southwest winds at Boston are not strictly land winds, and their passage over water before reaching Boston would tend to make them cooler in summer and warmer in winter than they would be if they had come from a land surface only.

At Portland the ratio for January amounts to five-sevenths. This indicates that the effect of easterly winds in raising the temperature is almost as great as that of southerly winds, even though both come largely off the sea. As previously mentioned, this effect of onshore winds decreases southward, because of the decreasing differences between air- and sea-temperatures, until at Cape Hatteras the ratio is only one-seventh. However, since Cape Hatteras is surrounded by water, there is local warming of the continental winds, which decreases the difference between temperatures with easterly and westerly winds.

Plus signs before the numerators of fractions for July show that in July, at every station except Atlantic City and Springfield, Ill., easterly winds bring lower temperatures than westerly winds. The fact that this is true even in the Central Plains is not attributable to the sea, but to the increased cloudiness in the northeast quadrant of a LOW. It is evident, however, that differences between southerly and northerly wind temperatures, and easterly and westerly wind temperatures, are not as great west of the Appalachians in summer as they are along the coast where, added to the lower temperature due to clouds caused both by cyclonic circulation and nearness of the sea, lower temperatures are also due to winds from the cool ocean. At Eastport, Portland, Boston, and Nantucket differences between easterly and westerly wind temperatures are very much greater than differences between northerly and southerly wind temperatures; this means that in July easterly winds bring temperatures farther below westerly wind temperatures than northerly wind temperatures are below southerly wind temperatures. If, as in January, the effect of land upon northeasterly wind temperatures and of sea upon south-westerly wind temperatures could be eliminated, the denominator might be so reduced and the numerator so increased as to indicate that sea-effects upon the temperatures are still greater compared with the effects of winds from southerly and northerly latitudes than they at first appear to be.

The relative effectiveness of winds in raising temperatures can conveniently be shown by vector diagrams, as in figures 4 and 5 for January and July, respectively. The resultants were determined by using the usual coordinate system, with the westerly minus easterly wind temperatures as one component, and the southerly minus northerly wind temperatures as the other component. On these figures all vectors point northward, showing the greater effectiveness of southerly than of northerly winds in raising temperature. Likewise, for January for all inland stations, except Chicago, which has the lake to the east, the vectors point eastward, indicating that westerly winds are more effective than easterlies in raising temperatures. The effect of winds from the ocean on temperatures along the New England coast is strikingly brought out by the *northwestward* direction of the arrows in this region.

The relative shortness of the vectors on the July chart clearly illustrates the smaller differences in temperatures

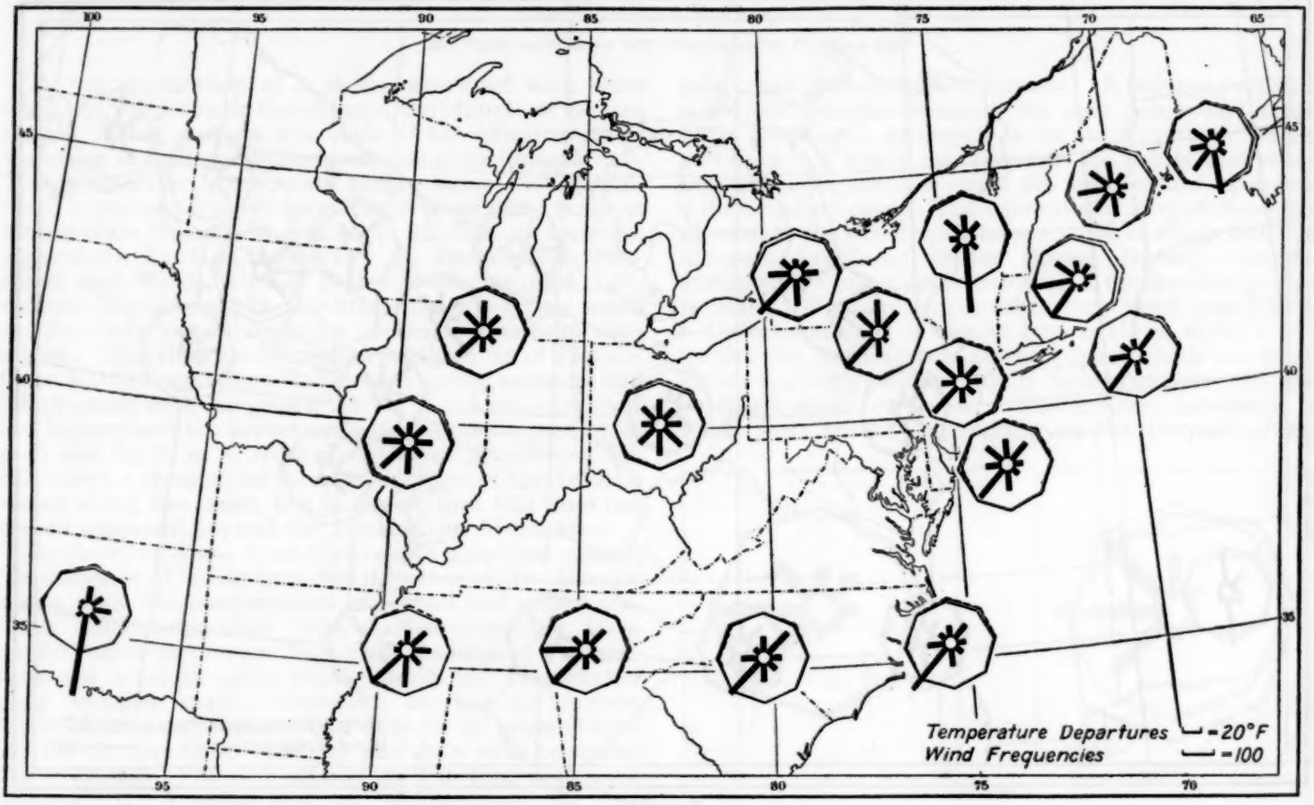


FIGURE 3.

accompanying north versus south winds, and east versus west winds, during the summer as compared with January. Along the New England coast in July, because the arrows point more easterly than northerly, it is

FIGURE 4.

evident that east-west winds bring greater temperature differences than north-south winds.

The magnitude of the marine effect on the average temperature of a coastal station depends on the frequency

FIGURE 5.

of the winds from the sea as well as upon the temperature departures of these winds. Because of the low frequencies of sea winds along the Atlantic coast, the marine effect is correspondingly small. To obtain a conservative numerical value, the mean temperatures of days with winds from the land, or from land and sea together, may be taken to represent how much colder January might be, and how much hotter July might be, in the absence of direct pure marine influence. As a rough approximation, the average of temperatures with winds from the north, northwest, west, southwest, and south, have been computed and compared with the average for all wind directions (table 2). By such an elimination of most of the purely sea-winds and their corresponding temperatures, the temperatures at all coastal stations except Nantucket in January would be from 0°.5 to 2°.7 lower than they actually are, and average July temperatures at these coastal stations would be from 0°.6 to 1°.1 higher than they actually are. Thus Boston would have about the same average July temperature as Atlantic City now has, were the ocean taken away from the east of Boston.

TABLE 1.—*Departures of the temperatures of westerly, easterly, southerly, and northerly winds from the monthly average*

January

Station	NW., W., SW.	NE., E., SE.	SE., S., SW.	NW., N., NE.	W-E / S-N
	°F.	°F.	°F.	°F.	°F.
1. Albany	+2.8	−6.5	+1.9	−5.5	+9.3/+7.4
2. Atlantic City	+1.4	+0.3	+5.4	−4.9	+1.1/+10.3
3. Boston	−0.1	+6.0	+8.3	−2.5	−6.1/+10.8
4. Buffalo	+2.7	−5.7	+2.9	−6.4	+8.4/+9.3
5. Cape Hatteras	−0.5	+1.4	+7.1	−6.3	−1.9/+13.4
6. Charlotte	−0.2	−0.1	+4.5	−3.1	+0.1/+7.6
7. Chattanooga	+0.3	−0.5	+6.7	−5.0	+0.8/+11.7
8. Chicago	−1.6	+2.9	+3.7	+0.1	−4.5/+3.6
9. Columbus	+4.0	−3.2	+1.8	−5.1	+7.2/+6.9
10. Eastport	−2.5	+5.1	+11.7	−5.9	−7.6/+17.6
11. Memphis	−0.2	−2.9	+6.3	−5.7	+2.7/+12.0
12. Nantucket	+2.3	+5.3	+10.5	−2.2	−3.0/+12.7
13. Oklahoma City	−0.3	−1.2	+3.5	−4.6	+0.9/+8.1
14. Philadelphia	−1.5	−0.1	+4.6	−2.9	+1.4/+7.5
15. Portland	−1.1	+9.0	+11.5	−2.9	−10.1/+14.4
16. Scranton	+0.5	−1.2	+2.7	−4.0	+1.7/+6.7
17. Springfield	−0.8	−0.9	+4.9	−4.7	+0.1/+9.6
July					
1. Albany	−0.3	−1.1	+0.7	−1.7	+0.8/+2.4
2. Atlantic City	−1.7	−1.4	−0.1	−1.2	−0.3/+1.1
3. Boston	+1.3	−4.9	−0.8	−2.8	+6.2/+2.0
4. Buffalo	−1.7	−1.8	+1.4	−4.7	+0.1/+6.1
5. Cape Hatteras	+0.7	−1.2	+0.6	−1.9	+1.9/+2.5
6. Charlotte	+1.5	−1.0	+0.1	+0.3	+2.5/−0.2
7. Chattanooga	+0.2	−1.3	+0.2	−1.1	+1.5/+1.3
8. Chicago	+1.0	−1.7	+1.2	−1.6	+2.7/+2.8
9. Columbus	+0.3	−0.4	+1.8	−2.6	+0.7/+4.4
10. Eastport	+2.8	−3.7	−0.9	−0.9	+6.5/0.0
11. Memphis	+0.8	−0.8	+1.0	−1.9	+1.6/+2.9
12. Nantucket	+1.6	−2.0	−0.5	−1.1	+3.6/+0.6
13. Oklahoma City	+0.1	−1.2	+0.2	−2.2	+1.3/+2.4
14. Philadelphia	+1.4	−1.9	−0.5	−0.9	+3.3/+0.4
15. Portland	+1.9	−3.3	−0.6	−1.8	+5.2/+1.2
16. Scranton	0.0	−0.1	+1.5	−1.7	+0.1/+3.2
17. Springfield	+0.9	+1.9	+1.3	−2.6	−1.0/+3.9

TABLE 2.—*Elimination of purely marine winds from mean monthly temperatures*

January

Station	Average monthly temperature	Mean temperature of days with N., NW., W., SW., and S. winds	Difference
	°F.	°F.	°F.
Eastport	20°4	17°7	2°7
Portland	20°7	19°1	1°6
Boston	26°7	25°9	0°8
Nantucket	27°6	29°1	−1°5
Atlantic City	31°7	31°2	0°5
Cape Hatteras	46°3	44°8	1°5
July			
Eastport	58°7	59°4	0°7
Portland	66°6	67°4	0°8
Boston	70°3	71°4	1°1
Nantucket	67°7	68°6	0°9
Atlantic City	71°6	72°4	0°8
Cape Hatteras	77°8	78°4	0°6

SOLAR RADIATION AT THE SCRIPPS INSTITUTION, LA JOLLA, CALIF., 1928–34

By BURT RICHARDSON, *Research Associate in Physics*

[Scripps Institution of Oceanography, La Jolla, Calif., March 1935]

Since July 1, 1928, solar radiation observations have been made at the Scripps Institution of Oceanography of the University of California at La Jolla, Calif. At the suggestion of H. H. Kimball in July 1929, the radiation data were collected and dated in a manner that conformed to the practice at the insolation stations in the United States; and since that time the Scripps Institution has furnished radiation records to the Weather Bureau, which has published them in the MONTHLY WEATHER REVIEW.

The Scripps Institution became interested in measuring solar radiation because of investigations in evaporation rates of open bodies of water, seasonal weather forecasts, and the dynamical theory of ocean tides and currents. With insolation records for 6 years available, one may with confidence use an average daily or monthly value of daytime radiation.

The Scripps Institution is located geographically at longitude 117°15′ west and latitude 32°52′ north. The element is mounted on the roof of Ritter Hall, approximately 100 feet above sea level and 200 feet from the ocean high-tide mark. No structures on the roof interfere with radiation from the sun and sky. Moreover, but little if any smoke or dust is present in the air at this station.

Measurements of the total radiation on a horizontal surface received from the sun and sky are made by a calibrated Weather Bureau thermoelectric pyrheliometer, no. 17. In the laboratory an Engelhard microammeter register records insolation by drawing out a curve which starts at sunrise, moves up to a maximum near noon, and gradually returns to the zero base line at sunset.

The evaluation of daily total radiation is accomplished in three ways: (1) By multiplying by the proper constant the average ordinate of the insolation curve for a 20-minute period; (2) by moving the tracing arm of a polar planimeter about the curve; and (3) by using the new integrating machine which has been available since June 1934.

Table 1 gives the average monthly values of daytime radiation for a 6-year period, measured in gram calories per square centimeter per day on a horizontal surface. The average per day for the entire period is 351.

Table 2 gives the average hourly value of daytime radiation for each month of the 6-year period.

Recalibrations of the instrument, and its ability to give consistent results, indicated that its behavior was satisfactory during the 6-year period. For example, the total insolation measured during the complete years of 1929, 1930, 1931, 1932, and 1933 are in the ratios 43, 42, 41, 40, and 40, which is a rather constant proportion. However, the element is now being replaced by an Eppley instrument.

In tables 3 and 4, respectively, are given the average monthly ocean surface temperatures measured on the Scripps Institution pier, and the average monthly air temperature measured at Lindbergh Field in San Diego (10 miles south of the Scripps Institution).

A comparison of the results obtained in measuring insolation, ocean surface, and air temperatures is given in table 5. Figure 1 shows this relation graphically.

A 3-month lag is observed in the maximum ocean surface and air temperatures, which occur in August while the maximum insolation occurs in May. Minimum insolation occurs in December, while minimum ocean surface temperature was observed in January and February and minimum air temperature in January.

On several occasions attempts were made to measure insolation directly by means of photoelectric cells, such as the Burt sodium, the National carbon potassium, Bell Laboratory caesium, and the Weston photronic; for weeks at a time the current readings of the exposed photoelectric cells were taken and compared with the pyrheliometer values, but no simple linear relation existed between the cells and the pyrheliometer, or between different photoelectric cells. However, this failure should not be surprising when one considers how a certain photoelectric cell has selective absorption for only a small part of the visible radiation (different for each cell), while the pyrheliometer measures not only all of the visible but also all the invisible as well.

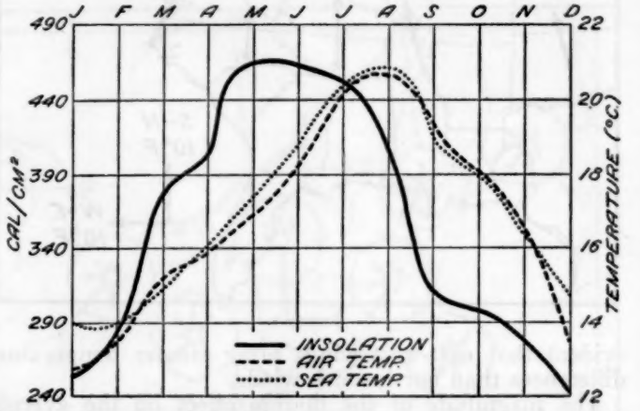


FIGURE 1.—Average monthly insolation, ocean surface temperature at La Jolla, and San Diego temperature, July 1, 1928–July 1, 1934, inclusive.

Measurements of insolation by means of small open-top insulated tanks gave excellent results. This method requires frequent measurements of losses and gains in heat through convection, conduction, radiation, and sensible heat, and losses through evaporation. The net number of calories gained by each square centimeter of the open-pan water surface is the insolation.

Although the 6-year records of radiation in La Jolla are of real value in physical, meteorological, and climatological studies, the records for a period of 12 years will be of even greater value, for this will cover the sunspot cycle, certain rainfall cycles, and certain atmospheric-pressure cycles over the Pacific Ocean.

TABLE 1.—*Average monthly values of daytime radiation measured in gram calories per square centimeter per day on a horizontal surface, Scripps Institution of Oceanography, La Jolla, July 1, 1928–July 1, 1934*

	1928	1929	1930	1931	1932	1933	1934	6-year monthly average
	gr. cal.	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*
January	-------	261.0	193.0	243.8	278.4	217.8	303.4	249.6
February	-------	312.2	256.2	274.4	283.4	294.3	292.3	285.5
March	-------	395.4	376.1	380.3	402.7	354.2	345.6	375.7
April	-------	403.0	416.1	364.7	448.7	321.7	488.9	407.2
May	-------	467.6	444.7	384.1	453.4	422.1	624.2	466.0
June	-------	449.5	437.5	462.9	478.5	409.0	523.0	460.1
July	545.1	452.4	476.6	495.0	406.6	329.6	-------	450.9
August	430.0	435.3	392.9	331.2	337.4	407.2	-------	389.0
September	293.0	295.0	364.9	349.1	232.9	328.4	-------	310.5
October	296.0	296.2	319.4	354.0	241.1	277.6	-------	297.4
November	291.0	288.3	260.6	260.4	241.1	322.0	-------	277.2
December	276.7	270.0	240.9	209.3	190.5	268.2	-------	242.6

TABLE 2.—*Average hourly values of daytime radiation measured in gram calories per square centimeter on a horizontal surface. Scripps Institution of Oceanography, La Jolla, July 1, 1934—July 1, 1934*

	Hour ending at—													
	A. M.						Noon	P. M.						
	6	7	8	9	10	11	12	1	2	3	4	5	6	7
	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal	gr. cal.	gr. cal.	gr. cal.
January			3.5	14.1	24.9	35.0	39.7	44.1	36.6	28.2	17.3	6.7	0.4	
February		0.3	5.4	15.5	25.5	35.4	40.4	41.0	39.2	34.2	23.8	11.5	2.2	0.1
March		2.5	12.0	24.0	36.4	44.6	49.7	51.6	48.1	42.0	31.0	16.5	4.9	.2
April	1.0	6.4	20.0	29.9	41.3	51.6	57.2	56.9	52.8	46.2	35.2	20.4	8.0	.8
May	2.0	9.6	19.6	31.1	42.1	53.3	60.7	61.6	56.1	48.2	38.3	24.2	10.8	1.8
June	2.3	8.7	17.4	29.9	40.5	49.7	56.1	58.6	54.6	48.3	39.3	26.0	12.4	2.7
July	1.6	6.5	15.1	27.3	38.5	48.3	54.3	54.9	51.2	44.8	35.5	22.7	11.1	2.5
August	.9	5.9	15.2	25.9	37.3	46.2	51.9	52.3	48.9	41.9	32.2	19.5	8.3	.9
September	.2	3.7	10.7	19.5	30.1	39.3	45.0	45.8	41.8	35.1	24.9	12.9	3.4	.1
October	.1	2.9	10.2	20.8	31.2	38.2	42.0	42.3	37.7	30.0	18.1	7.0	.6	
November		.8	8.6	20.0	31.4	38.2	41.8	40.9	33.7	24.9	15.3	5.0	.7	
December			4.4	15.7	25.4	33.1	36.2	36.2	32.0	22.3	12.5	3.0		
6-year hourly average of daytime radiation	.7	3.9	11.8	22.8	33.7	42.7	47.9	48.9	44.4	37.2	27.0	14.6	5.2	.8

TABLE 3.—*Average monthly values of the ocean surface temperature measured in degrees Centigrade, Scripps Institution of Oceanography Pier, La Jolla, Calif., July 1, 1928–July 1, 1934*

	1928	1929	1930	1931	1932	1933	1934	6-year monthly average
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
January		13.9	14.7	15.3	13.3	13.0	13.3	14.0
February		13.3	14.8	16.1	13.3	12.6	14.0	14.0
March		13.8	14.9	16.8	14.8	13.5	15.7	14.9
April		14.5	16.6	18.0	14.8	14.9	17.3	16.0
May		17.6	17.2	19.0	16.1	15.4	19.2	17.4
June		18.7	18.7	20.0	19.0	17.3	16.1	18.8
July	19.8	21.3	19.4	23.7	19.5	18.7		20.4
August	20.1	21.9	21.6	23.3	18.8	19.0		20.8
September	18.1	20.0	19.7	20.1	18.6	17.0		18.9
October	17.4	18.5	18.1	18.8	17.4	17.0		17.9
November	15.7	16.8	17.5	16.5	16.2	15.4		16.3
December	14.6	16.0	16.2	14.1	14.0	13.9		14.7

TABLE 4.—*Average monthly air temperature at San Diego, Calif., measured in degrees Centigrade, July 1, 1928–July 1, 1934*

	1928	1929	1930	1931	1932	1933	1934	6-year monthly average
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
January		12.5	13.2	14.3	11.2	11.6	13.4	12.7
February		11.8	14.4	15.1	13.1	11.5	14.6	13.4
March		13.1	15.4	16.6	15.0	13.9	16.6	15.1
April		14.2	16.7	17.7	15.7	14.3	16.8	15.9
May		17.1	15.6	19.0	16.6	14.6	18.2	16.9
June		18.5	18.1	20.4	17.7	16.5	17.8	18.2
July	19.2	20.8	20.9	23.1	18.7	18.6		20.2
August	19.6	22.2	21.3	23.2	18.9	19.2		20.7
September	19.0	20.1	19.4	21.0	18.7	17.1		19.2
October	16.8	19.3	18.2	19.2	17.3	16.9		18.0
November	15.7	16.7	17.2	14.2	17.9	17.3		16.5
December	13.4	15.7	13.9	12.1	12.4	12.8		13.3

TABLE 5.—*Average monthly daytime radiation in La Jolla, Calif., ocean surface temperatures at La Jolla, air temperatures in San Diego, July 1, 1928–July 1, 1934*

	La Jolla radiation	Surface temperatures, La Jolla	San Diego air temperatures
	gr. cal.	°C.	°C.
January	249.6	14.0	12.7
February	285.5	14.0	13.4
March	375.7	14.9	15.1
April	407.2	16.0	15.9
May	466.0	17.4	16.9
June	460.1	18.8	18.2
July	450.9	20.4	20.2
August	389.0	20.8	20.7
September	310.5	18.9	19.2
October	297.4	17.9	18.0
November	277.2	16.3	16.5
December	242.6	14.7	13.3

THE TEMPERATURES OF NEW ENGLAND[1]

By PHIL E. CHURCH

New England occupies about 66,000 square miles of the eastern margin of the continent between the parallels of 41° N. and 47° N.

Within this area are various types of relief which have an influence on the temperatures. A slightly irregular coastal lowland borders a sinuous coast. Hilly sections form the transition zone between the coastal lowland and the mountainous regions inland.

The backbone of New England is the mountainous northeastward extension of the Appalachian Mountain system. In western Massachusetts it forms the Berkshire Hills, in Vermont the Green Nountains, in New Hampshire the White Mountains, a continuation of which to the northeast is part of the Maine-Quebec boundary. No definite ranges make up the highlands of northern and western Maine. In various places the mountains of New England rise to moderate heights: Mount Greylock in western Massachusetts, 3,535 feet; Mount Mansfield in Vermont, 4,389 feet; Mount Monadnock in southern New Hampshire, 3,166 feet; Mount Washington, the highest in the Presidential Range and New England, 6,293, with several others nearby having an altitude over

[1] Abstract of a thesis presented in partial fulfillment of the degree of master of arts at Clark University, under the supervision of Prof. Charles F. Brooks.

4,000 feet, and Mount Katahdin in north central Maine, 5,273 feet.

The Green Mountains of Vermont extend through the entire length of the State from north to south. Their southward extension in western Massachusetts forms the Berkshire Hills, the Hoosac and Taconic Mountains. In Connecticut they diminish to low hills which disappear near Long Island Sound.

The White Mountains comprise the highland near the western edge of New Hampshire and continue southward into Massachusetts as the central highland there. Farther south the altitude decreases to low hills. The higher altitudes show a decided lowering of temperatures.

In eastern Maine, just back from the coast, is an area of perhaps 1,000 square miles having an altitude higher than 500 feet. This is the only coastal area of appreciable extent, along the lowland that skirts the whole of the New England coast, which has a noticeable effect on the temperature. The lowland strip, under 500 feet, varies from a few miles to about 100 miles in width. Cape Cod, Marthas Vineyard, Nantucket, and Block Island are considered a part of this coastal lowland.

Several low and wide river valleys have enough contrast in relief between the valley floor and the highlands on either side to make an appreciable difference in temperature. Some of these are the valleys of the Housatonic, Conn., Quinebaug, Merrimac, Saco, Androscoggin, Penobscot, St. Croix, and Aroostock Rivers and the Lake Champlain lowland.

New England is exposed to the extreme temperatures of the interior because of its position on the lee side of the continent, but these temperatures are moderated somewhat by the Atlantic Ocean. The shifting of the winds, due to the passage of high and low pressure areas, alternately brings air from over the land and ocean. The effects of the ocean often linger, thanks to the mountain barrier on the north and west.

The climate of New England is dominated by cyclonic activity bringing frequent and marked changes in the weather. Winter is moderately long and cold with a continuous snow cover from January to the middle of March; spring comes discouragingly late; summer passes after a few brief periods of high temperatures; autumn is clear, crisp and delightful. Precipitation is evenly distributed throughout the year. In all seasons sunny days are frequent.

The temperatures are characterized by wide differences resulting from the latitudinal range of 6°, the moderate differences in altitude, the proximity of the Atlantic Ocean, the continental winds, and the character of the local terrain.

The mean winter temperatures differ by more than 22° F. from northern Maine (Van Buren, 10.6° F.) to the islands off the south coast (Nantucket, 32.9° F.). This large contrast may be accounted for by the prevailing cold northwest winds. These winds attain somewhat higher temperatures along the coastal margin. Spring is considerably warmer and the contrast from north to south is much less than in the winter. The mean spring temperature map reveals a warmer belt on the lowlands inland from the coast. In summer there is a small difference in temperature from north to south with a greater definition of the warm inland belt and the cool coastal margin. Southwest wind prevails at this season. In autumn the small contrast from north to south continues though the wind prevails from the northwest in the latter part of the season.

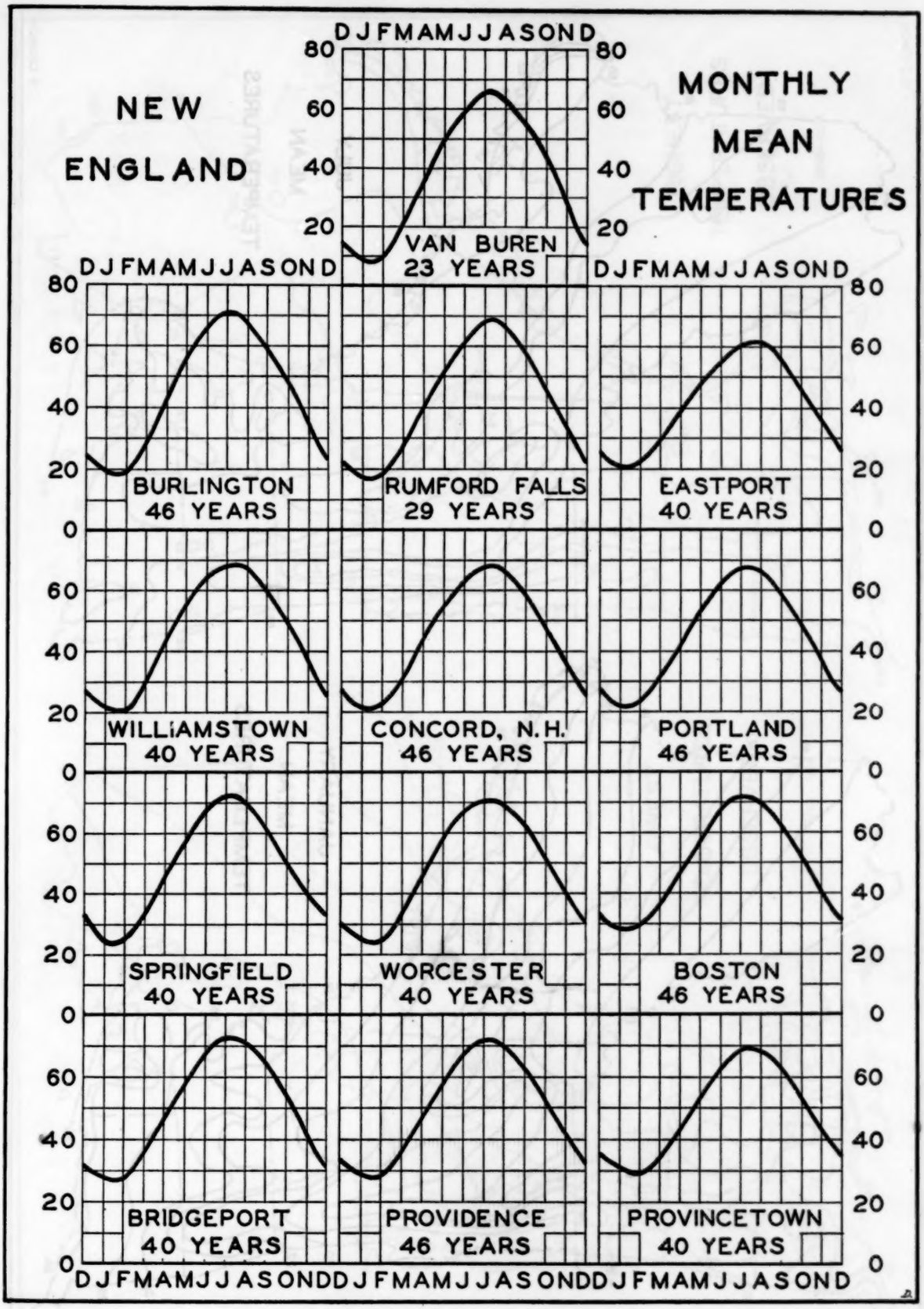
The lowest monthly means in New England come in January in the north and in February along the south coast. A difference of 24° F. within the small latitudinal range in midwinter is a contrast greater than that for the same difference of latitude in interior United States. This contrast results from the oceanic influence in the south and the continentality in the north. Temperatures increase rapidly and evenly from a minimum in January to a maximum in July, except at a few stations of more marine characteristics. At this time there is less than 10° F. difference over all New England, the means being from 64° to 72° F. Temperatures decline evenly from July to January. The average daily range is greatest in the north, 22° F., where continental effects are most pronounced. In the south along the coastal margin the range is much less.

There is a difference of more than 12° F. from north to south in the mean annual temperature. The southern part enjoys the highest mean temperature, 50° F., and the northern part the lowest, about 36° F. The mean annual range is considerable, Van Buren, in the interior of northern Maine having the most, 57° F. Along the coast the marine influence limits the range to 45° F. or less while on the island of Nantucket the range is 37° F., the least in New England.

Frost date maps express well the spring and autumn temperature distribution. Near Buzzards Bay the average date of the last killing frost in spring falls on or before April 21. North of central Maine and in the highlands of New Hampshire and Vermont the last frost comes after June 1, on the average. This difference of nearly 6 weeks is due, for the most part, to the moderating influence of the ocean along the coast, while in the north the effect of land mass and altitude prevail. The valleys of the Connecticut River and Lake Champlain deflect the frost date lines to the north.

In the north and the highlands the average date of the first killing frost in fall is about September 11. In southern New England it arrives early in October. But in the Cape Cod region it does not come until after November 1. However, Taunton, in the same latitude and inland about 25 miles, suffers from killing frost by October 1.

The great variation of the frost dates produces wide differences in the length of the growing season. Northern Maine has less than 100 days free from killing frost. In contrast, Cape Cod has more than 200 days, though Taunton has but 140. Along the coast the growing season is at least 150 days. The best agricultural land of New England is included within the area having a frost-free season of 130 days or more. The highland areas have a short growing season because of the lower mean temperature of both summer and winter.


NEW ENGLAND
MONTHLY MEAN TEMPERATURES
D J F M A M J J A S O N D
80
60
40
20
0
VAN BUREN 23 YEARS
BURLINGTON 46 YEARS
RUMFORD FALLS 29 YEARS
EASTPORT 40 YEARS
WILLIAMSTOWN 40 YEARS
CONCORD, N.H. 46 YEARS
PORTLAND 46 YEARS
SPRINGFIELD 40 YEARS
WORCESTER 40 YEARS
BOSTON 46 YEARS
BRIDGEPORT 40 YEARS
PROVIDENCE 46 YEARS
PROVINCETOWN 40 YEARS

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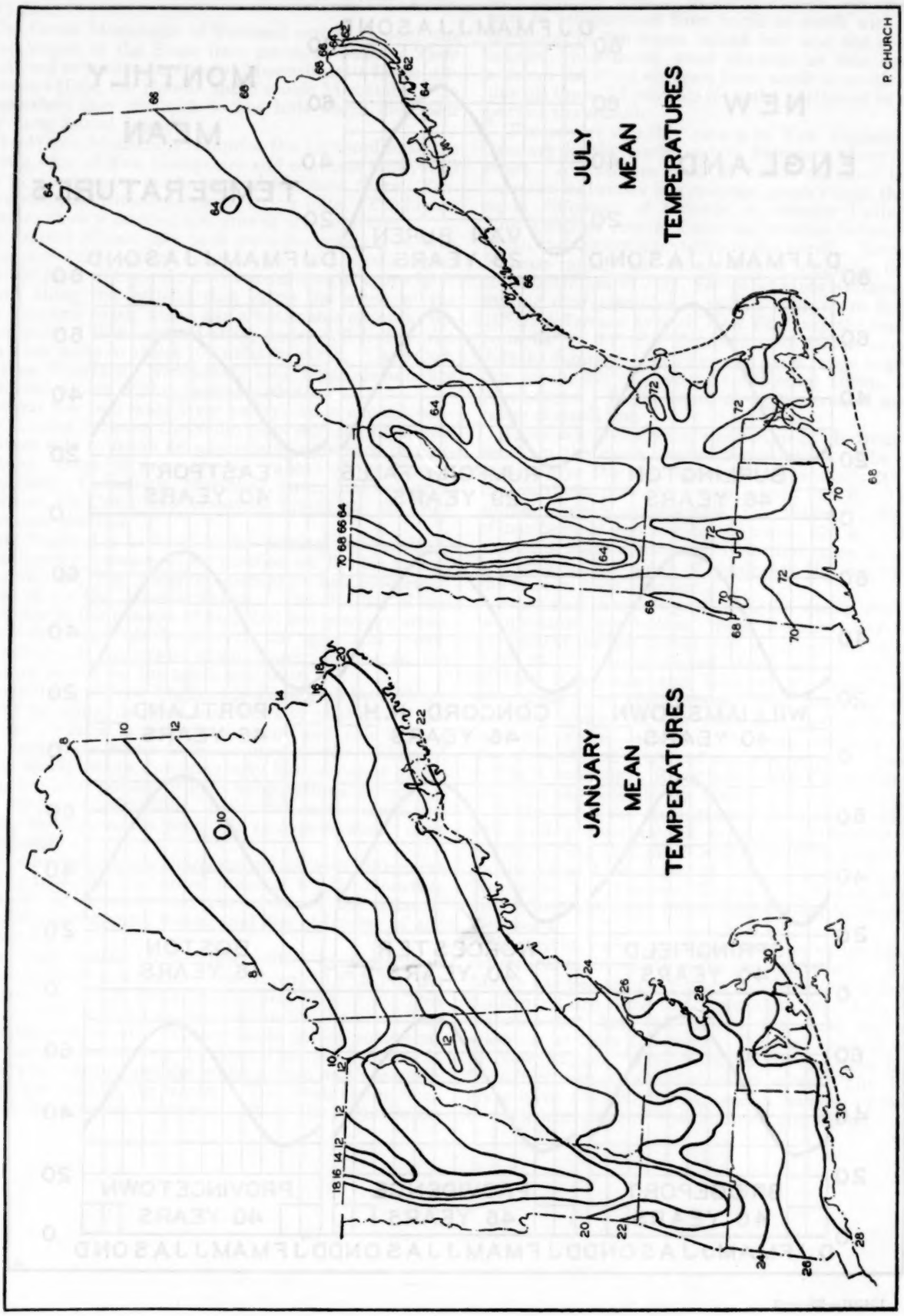
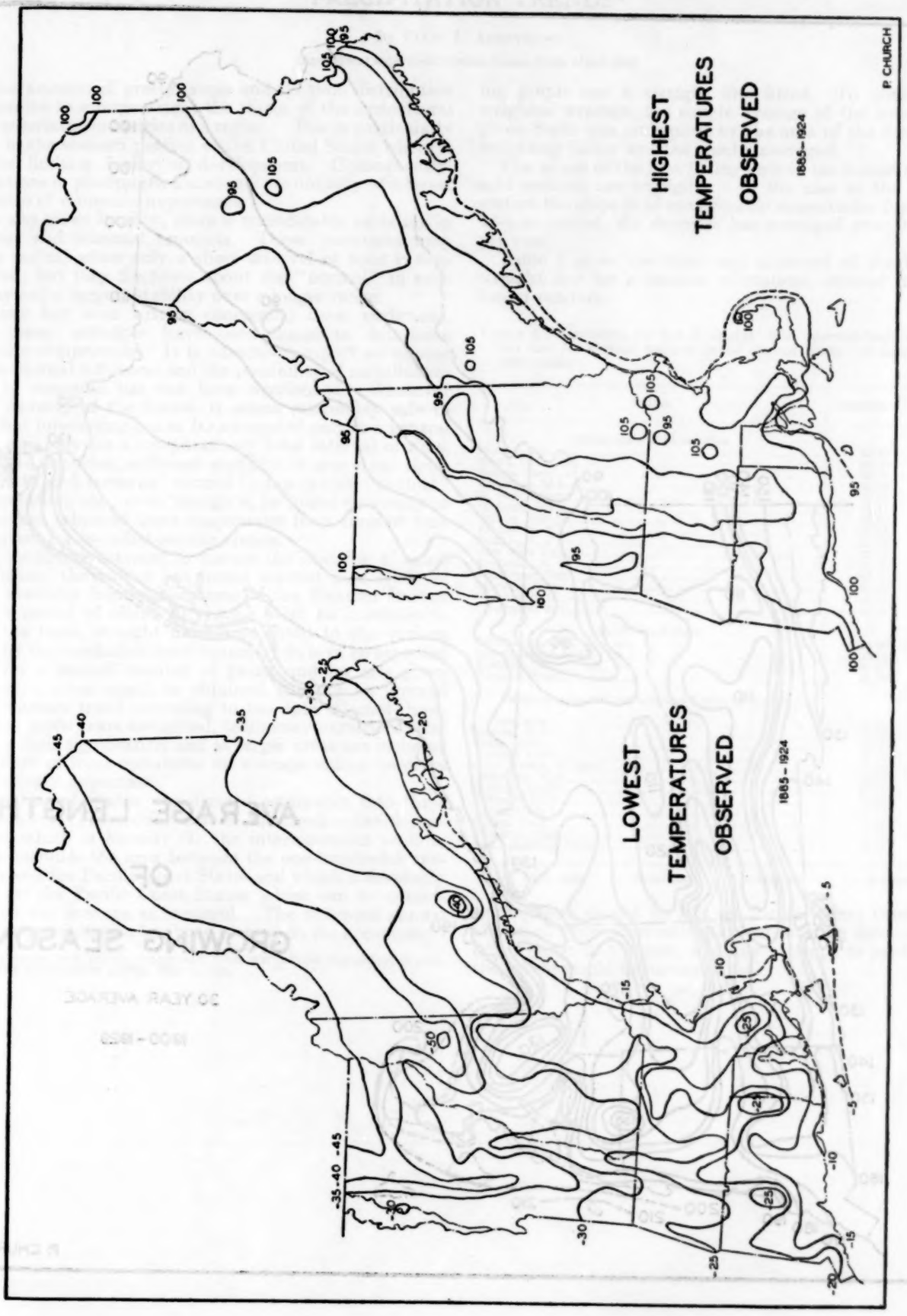
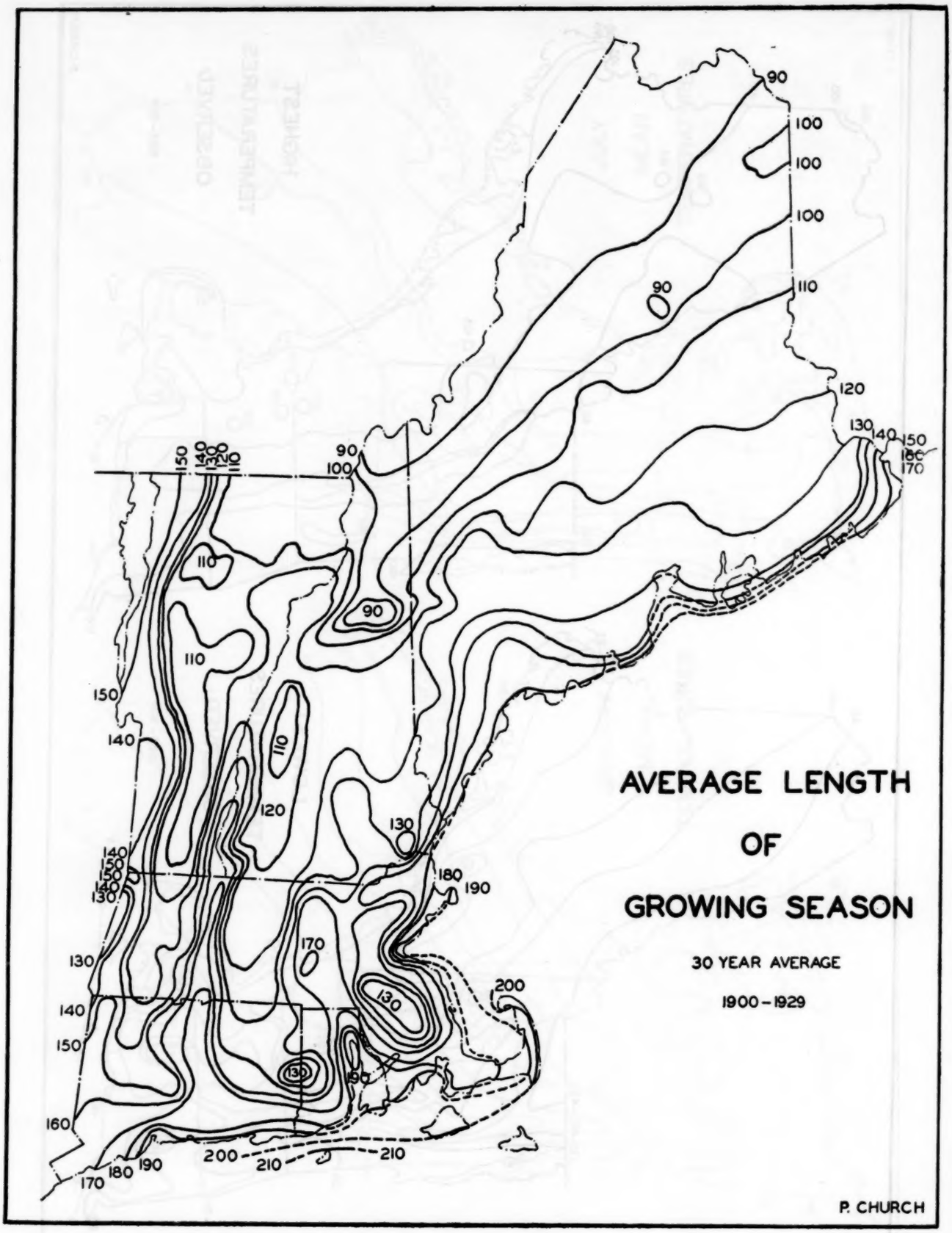

JULY
MEAN
TEMPERATURES
JANUARY
MEAN
TEMPERATURES
P. CHURCH


HIGHEST
TEMPERATURES
OBSERVED
1885-1924
LOWEST
TEMPERATURES
OBSERVED
1885-1924
P. CHURCH


AVERAGE LENGTH
OF
GROWING SEASON
30 YEAR AVERAGE
1900 - 1929
P. CHURCH

PRECIPITATION TRENDS [1]

By ELLIS L. ARMSTRONG

[Agricultural Experiment Station, Logan, Utah, March 1935]

The amount of precipitation and its time distribution determine to a large extent the status of the agricultural and associated industries of a region. This is particularly true in the western portion of the United States where it is the limiting factor of development. Consequently, variations in precipitation amounts are not only of interest but also of economic importance.

In any given locality, there is considerable variation in annual and seasonal amounts. These variations may seem radical when only a short interval of time is considered, but they fluctuate about the "normal" in such a way as to suggest stability over a longer range.

Much has been written concerning these variations, and many attempts have been made to determine periodic components. It is natural to expect an annual and a diurnal influence; and the possibility of an influence due to sunspots has not been overlooked. Whatever may develop in the future, it seems reasonably safe to say that forecasting has so far succeeded only in a general way, and only for a comparatively brief interval of time. There is, however, sufficient stability to give some significance to such terms as "normal" temperature, "normal" precipitation, etc., even though it be found necessary to revise the values of these magnitudes from time to time to correct for so-called secular trends.

Without any attempt to discuss the question of cause and effect, the author has found interest in a study of data available from publications of the Weather Bureau over a period of about 40 years. With no intention to bias the facts, straight lines were fitted to the various data by the method of least squares. It is to be expected that for a limited number of years, and for any given locality, a slope might be obtained, showing an upward or downward trend according to the data selected; however, as more years are added, temporary variations tend to lose their significance, and as larger areas are included the effect of local variations on average values becomes decreasingly important.

The United States was divided arbitrarily into three sections: (1) The section east of the one-hundredth meridian, which is humid; (2) the intermountain section, which includes the area between the one-hundredth meridian and the Pacific Coast States and which is decidedly arid; (3) the Pacific Coast States, which can be considered on the average as semiarid. The weighted annual average precipitation has been plotted on the accompanying graph and a straight line fitted. To obtain this weighted average, the simple average of the towns of a given State was multiplied by the area of the State as a weighting factor and the results averaged.

The slopes of the best fitting lines in the humid and the arid sections are negligible. In the case of the coastal section the slope is of considerable magnitude; during the 44-year-period, the decrease has averaged over 0.3 inch per year.

Table 1 gives the slope and intercept of the best fit straight line for a number of stations selected more or less at random.

TABLE 1.—*Constants for best fit straight lines representing precipitation data for various stations in the United States (40-year period, 1890–1930)*

Station	Intercept	Slope
Section east of 100th meridian		
Mobile, Ala.	62.03	−0.029
Peoria, Ill.	35.89	−0.012
Boston, Mass.	39.24	−0.037
Baltimore, Md.	42.83	−0.100
St. Paul, Minn.	30.02	−0.138
St. Louis, Mo.	36.11	+0.039
Omaha, Nebr.	28.34	−0.120
Albany, N. Y.	34.34	−0.077
Buffalo, N. Y.	36.85	−0.133
New York City, N. Y.	43.41	+0.093
Rochester, N. Y.	33.65	−0.071
Cincinnati, Ohio	38.14	+0.178
Marietta, Ohio	38.65	+0.124
Camden, S. C.	45.15	+0.121
Charleston, S. C.	47.95	−0.275
Pacific Coast States		
Sacramento, Calif.	19.09	−0.183
San Francisco, Calif.	20.54	−0.012
Portland, Oreg.	40.15	−0.042
Tacoma, Wash.	49.31	−0.532
Section between 100th meridian and Pacific Coast States		
Tucson, Ariz.	10.54	+0.033
Denver, Colo.	14.39	−0.011
Boise, Idaho	13.68	−0.042
Porthill, Idaho	20.69	−0.187
State College, N. Mex.	6.68	+0.116
Cheyenne, Wyo.	14.57	+0.070
Corinne, Utah [1]	10.92	+0.062
Fillmore, Utah	14.38	+0.003
Logan, Utah [2]	15.34	+0.039
Ogden, Utah [3]	12.34	+0.129
Parowan, Utah	12.73	+0.016
Salt Lake City, Utah [4]	16.54	−0.014

[1] 1876–1930. [2] 1890–1934. [3] 1871–1930. [4] 1875–1934.

Emphasis should be laid on the fact that these data are based upon observational facts covering definite periods of years in the past, and any attempt to predict for the future would be unwarranted.

[1] Contribution from physics department, Utah Agricultural Experiment Station. Publication authorized by director, Mar. 11, 1935.

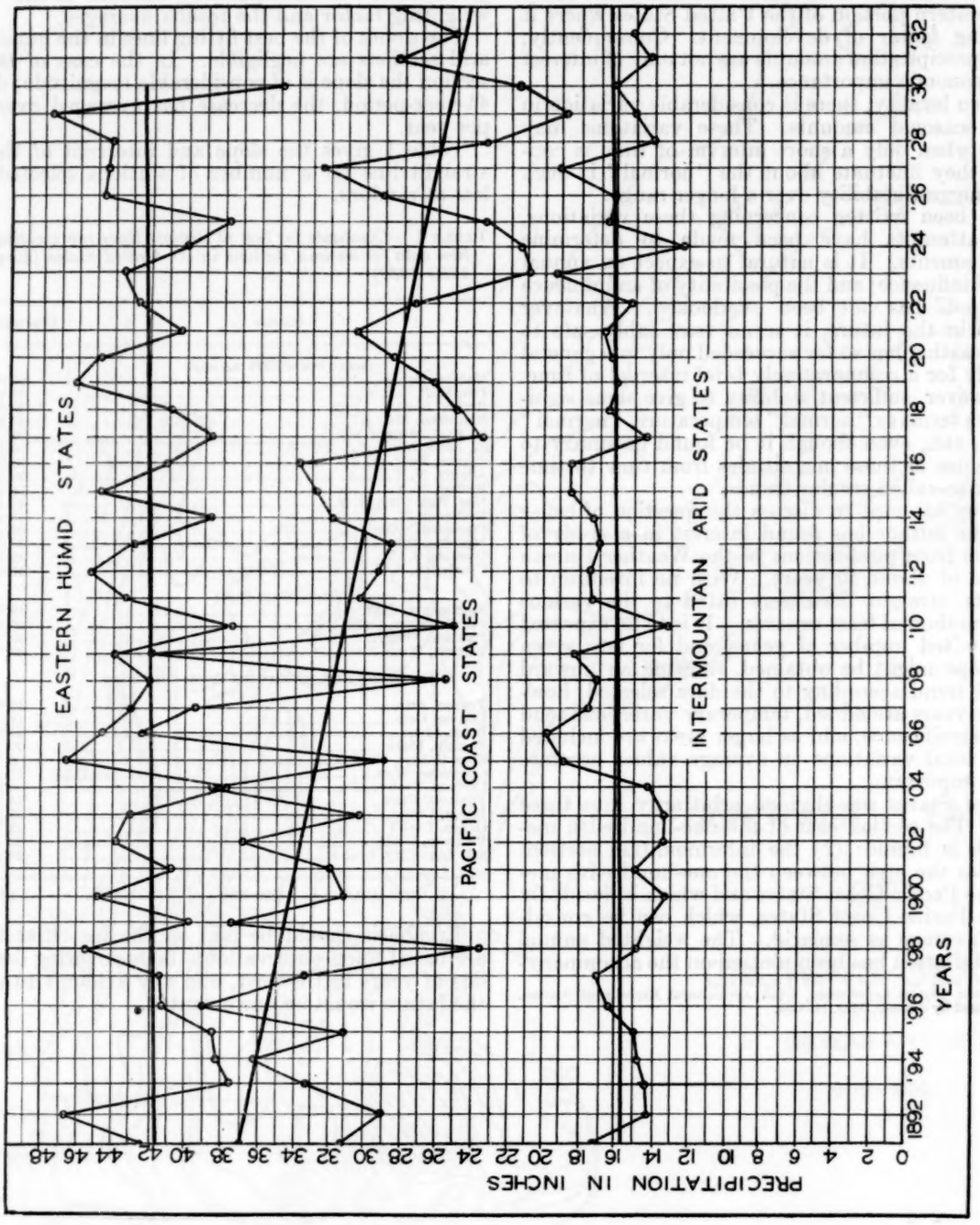


FIGURE 1.—Yearly average precipitation and trends for eastern section, intermountain section, and Pacific coast section, 1891–1933.

WEATHER OF JUNE AS INDICATING THE WEATHER OF THE FOLLOWING MAY IN IDAHO

By H. G. CARTER

[Weather Bureau, Boise, Idaho, February 1935]

The results of tabulations from the records of the Boise Weather Bureau Station, and of the Idaho Section, may be summarized as follows:

Boise records:
- Temperature:
  - Warm Junes, followed quite generally by warm Mays; followed by wet or dry Mays in about same ratio.
  - Cold Junes, followed quite generally by cold Mays; followed by wet or dry Mays in about same ratio.
- Precipitation:
  - Wet Junes; followed by warm or cold, and wet or dry Mays in about same ratio.
  - Dry Junes, followed by slightly more dry and slightly more cold Mays, but difference was small.

Idaho records:
- Temperature:
  - Warm Junes, followed quite generally by dry and warm Mays.
  - Cold Junes, followed quite generally by cold and wet Mays.
- Precipitation: Wet Junes, followed by slightly more wet and slightly more cold Mays.
  - Dry Junes, followed quite generally by dry Mays; by warm or cold Mays in about same ratio.

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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING MARCH 1935

By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

For a description of instruments employed and their exposures the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows a deficiency in the amount of solar radiation received at normal incidence at all stations for which normals have been computed. While no observations of this character were made during severe dust storms owing to cloudy skies during their passage, radiation values were greatly lessened by dust on other days.

Table 2 shows an excess in the amount of total solar and sky radiation received on a horizontal surface at Lincoln, Chicago, New York, Fresno, and Fairbanks and a deficiency at all other stations. The value of 9 gram-calories per square centimeter of horizontal surface recorded for the entire day of the 16th of March at Madison during the passage of a dust storm is the lowest daily value ever recorded at that station.

Polarization measurements obtained on 6 days at Washington give a mean of 59 percent with a maximum of 64 percent on both the 22d and 26th. Both of these values are slightly below the March normals for Washington. No polarization observations were made at Madison because of snow and ice surfaces throughout the month.

Although routine atmospheric dust counts have been discontinued by the Bureau, a few counts were made in March because of the passage of some midwestern soil over the city. The highest count of 3,255 per cc is about a quarter of the number of particles per cc measured May 11, 1934, on which date Washington experienced the worst dust storm since this type of measurement was started. Table 4 gives the results of the March counts.

TABLE 1.—*Solar radiation intensities during March 1935*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Mar. 15	3.30					1.34					3.30
Mar. 18	4.75	0.82	0.91	1.07	1.26						2.26
Mar. 26	4.75					1.29	1.30	1.09	0.92	0.80	3.81
Mar. 29	4.37	.36	.53	.83	1.10	1.45	1.08	0.80	.64		3.00
Mar. 30	4.37		.36	.51	0.66	0.73					3.99
Means		(.59)	.60	.80	1.01	1.20	(1.19)	(.94)	(.78)	(.80)	
Departures		−.13	−.21	−.15	−.14	−.22	+.06	.00	.00	+.10	

TABLE 1.—*Solar radiation intensities during March 1935*—Contd

[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Mar. 1	3.00				1.19						3.45
Mar. 12	1.96		1.04	1.16							2.16
Mar. 21	5.16	.88	.99				0.86				4.17
Mar. 26	4.75		.40	.60	.81						5.56
Means		(.88)	.81	(.88)	(1.00)		(.86)				
Departures		−.07	−.22	−.28	−.31		−.43				
LINCOLN, NEBR.											
Mar. 2	3.99			1.05							5.79
Mar. 5	7.57	0.96	1.06	1.23	1.42	1.58					2.74
Mar. 7	1.24			1.25	1.45	1.59	1.25	1.16	0.97	0.86	1.68
Mar. 11	3.15					1.64	1.44	1.25	1.12	.98	2.16
Mar. 12	3.30	.92	1.07	1.22							3.45
Mar. 13	4.75	.93	1.00	1.19	1.34						4.57
Mar. 14	5.79				1.17	1.31					4.37
Mar. 23	3.00		.61	.96	1.30	1.84					4.17
Mar. 25	8.18				.83		1.06	.84	.71	.61	4.95
Mar. 26	4.95	.59	.73	.88	1.05	1.35					5.36
Means		.85	.89	1.11	1.22	1.59	1.25	1.08	.93	.82	
Departures		+.01	−.04	+.02	−.05	−.01	−.03	−.01	−.01	.00	
BLUE HILL, MASS.											
Mar. 1	1.5			1.13	1.32		1.37				1.4
Mar. 3	4.6				1.12		1.19				2.2
Mar. 4	1.3			1.08	1.34						1.0
Mar. 8	2.3					1.52	1.27	1.12	1.06	1.00	1.5
Mar. 9	1.3		0.95	1.15	1.34	1.45	1.36	1.20			1.0
Mar. 13	4.2						1.18				5.6
Mar. 14	2.1		.76	.94	1.18	1.52					1.4
Mar. 16	5.0						1.13	1.08	1.03		5.2
Mar. 18	1.3		1.04	1.20	1.36	1.62	1.29				1.2
Mar. 20	5.6		.64	.91	1.07	1.46	1.25				3.8
Mar. 22	2.3	0.94	1.05	1.20	1.39	1.59	1.31	1.06			.8
Mar. 24	3.2	.74	.87	1.02	1.24	1.51	1.28	1.15	1.03		2.3
Mar. 25	2.4					1.34	.95	.81			2.0
Mar. 26	2.3	.86	.97	1.11	1.27	1.59	1.36	1.14	1.00	.87	1.4
Mar. 27	1.3	.86	.99	1.16	1.36	1.57	1.32	1.20	1.11	.87	1.0
Mar. 29	3.5				1.12	1.20					1.9
Mar. 30	4.8					1.50	1.27	1.07	.88	.72	2.1
Averages		.85	.91	1.09	1.26	1.49	1.25	1.09	1.02	.86	

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Miami	New Orleans	Riverside	Blue Hill	Friday Harbor	Ithaca
	Gram-calories per square centimeter												
1935	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Feb. 26	301	293	349	256	268	337	147	388	286	330	300	187	207
Mar. 5	169	202	357	189	209	424	194	343	110	390	282	189	245
Mar. 12	317	288	371	246	261	487	198	414	337	442	316	224	229
Mar. 19	232	253	414	253	299	409	244	503	393	484	378	310	297
Mar. 26	303	288	407	319	348	550	295	461	265	351	459	399	257
	Departures from weekly normals												
Feb. 26	+11	+12	+7	+45	+27	−41	+1	−88	+18	−34			
Mar. 5	−150	−96	+3	−15	−54	+30	+34	−148	−171	−24			
Mar. 12	−14	−27	−5	+32	−16	+71	0	−12	+22	+3			
Mar. 19	−106	−65	+19	+15	+14	−45	+75	+45	+42	+48			
Mar. 26	−41	−61	0	+90	+87	+57	+17	−7	−30	−109			
	Accumulated departures on												
	−434	−3,836	−189	+406	+1,022	−98	+603	−840	−784	−1,610			

(WB—7-30-34—1,000) 295

TABLE 3.—*Total, I_m, and screened, I_p, I_r, solar radiation intensity measurements, obtained during March 1935, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Date and hour angle	Solar altitude	Air mass	I_m	I_p	I_r	β_{1m-r}	β_{1p-r}	β_{m-r}	$\frac{I_{w-p}}{1.94}$	$\frac{I_{w-p}-I_m}{1.94}$	w	Air-mass type
									Percentage of solar constant			
Mar. 1, 1935	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
1:27 a. m.	36 14	1.69	1.383	0.964	0.783	0.041	0.069	0.055	76.1	6.2	5.9	NP_P
1:51 p. m.	34 02	1.78	1.408	1.024	.815	.040	.021	.030	80.3	9.1	7.7	
Mar. 3												
1:48 a. m.	34 58	1.74	1.280	.910	.748	.049	.098	.074	72.2	7.4	7.6	
11:23 a. m.	38 13	1.61	1.336	.957	.774	.066	.072	.069	74.5	6.9	8.2	P_C
0:28 a. m.	40 23	1.54	1.344	.943	.763	.060	.077	.068	75.2	7.2	8.6	
0:05 p. m.	40 47	1.53	1.356	.958	.768	.057	.053	.060	76.8	8.1	8.1	
Mar. 4												
0:55 a. m.	39 36	1.57	1.405	.987	.767	.029	.024	.026	82.8	11.6	9.0	P_C
Mar. 8												
0:03 p. m.	42 44	1.47	1.341	.935	.764	.050	.101	.076	74.8	6.7	8.8	P_C;T_O&T_A
0:40 p. m.	41 52	1.49	1.404	.983	.804	.056	.084	.070	75.5	4.2	7.9	Aloft.
2:10 p. m.	34 15	1.78	1.303	.919	.755	.058	.092	.075	71.5	5.3	7.0	
4:38 p. m.	11 30	5.12	.993	.764	.646							
Mar. 9												
1:54 a. m.	36 26	1.68	1.404	.991	.803	.042	.051	.046	77.8	6.5	7.7	
0:47 a. m.	41 55	1.49	1.230	.879	.717	.102	.121	.112	69.4	6.9	8.9	
0:29 a. m.	42 40	1.47	1.248	.901	.727	.102	.075	.088	73.2	9.9	9.4	P_C
0:31 p. m.	42 36	1.48	1.318	.936	.757	.099	.088	.094	73.9	6.9	8.8	
0:54 p. m.	41 32	1.51	1.357	.954	.785	.064	.098	.081	73.9	4.5	7.9	
1:22 p. m.	39 33	1.57	1.481	1.030	.829	.021	.041	.031	81.8	6.5	7.7	
Mar. 14												
2:08 a. m.	28 15	2.11	1.155	.855	.702	.087	.100	.094	64.6	5.8	5.5	
2:44 a. m.	31 48	1.89	1.222	.865	.715	.070	.106	.088	68.1	5.9	6.8	P_C
1:40 a. m.	39 44	1.56	1.270	.893	.730	.079	.109	.094	72.0	7.3	8.5	
0:31 a. m.	44 33	1.42	1.374	.994	.774	.059	.112	.086	73.6	3.6	7.6	T_A aloft
Mar. 16												
2:52 p. m.	31 16	1.92	1.140	.801	.659	.077	.119	.098	66.1	8.0	7.0	NP_C NT_P aloft
Mar. 18												
3:02 a. m.	30 24	1.97	1.375	.962	.796	.033	.075	.054	73.6	3.3	5.7	
2:40 a. m.	32 38	1.86	1.202	.946	.776	.129	.074	.102	66.0	4.6	6.5	P_C
0:28 a. m.	46 13	1.39	1.510	1.145	.883	.024		.024	84.6	7.5	9.6	
0:10 p. m.	46 36	1.38	1.515	1.143	.831	.020		.020	85.5	8.1	9.8	
Mar. 20												
2:18 a. m.	37 20	1.65	1.150	.824	.650	.088	.076	.082	71.8	13.0	7.6	
1:55 a. m.	40 12	1.55	1.241	.850	.689	.058	.074	.066	75.6	12.1	9.2	P_C
1:36 a. m.	42 27	1.48	1.264	.852	.699	.068	.144	.106	71.0	6.4	8.8	
0:01 p. m.	47 27	1.35	1.318	.896	.720	.059	.098	.078	76.2	8.8	10.0	NP_C aloft
1:35 p. m.	42 23	1.48	1.321	.904	.725	.050	.069	.060	72.4	4.9	8.3	
3:24 p. m.	27 32	2.16	1.243	.875	.707	.039	.060	.050	72.4	8.8	6.3	
Mar. 22												
3:15 a. m.	29 35	2.02	1.383	.975	.789	.026	.058	.042	75.8	5.0	6.1	
2:17 a. m.	38 10	1.61	1.445	1.009	.800	.018	.020	.019	84.0	10.0	8.3	P_C
0:47 a. m.	46 56	1.37	1.507	1.028	.819	.017	.031	.024	85.0	7.8	9.8	
0:14 p. m.	48 08	1.34	1.512	1.021	.817	.014	.045	.030	84.1	6.7	9.8	
1:52 p. m.	41 17	1.51	1.435	.998	.799	.033	.048	.040	81.3	7.8	8.9	
3:22 p. m.	28 28	2.09	1.308	.942	.764	.038	.049	.044	74.5	7.6	6.4	

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during March 1935, and determinations of the atmospheric turbidity fator β, and water-vapor content, w=depth in millimeters, if precipitated*—Continued

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w=0}}{1.94}$ Percentage of solar constant	$\frac{I_{w=0}-I_m}{1.94}$ Percentage of solar constant	w	Air-mass type
Mar. 24	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
2:52 a. m.	33 48	1.79	1.292	0.905	0.732	0.047	0.074	0.060	74.3	8.1	7.5	NPc
2:28 a. m.	37 18	1.65	1.355	.941	.758	.055	.035	.045	78.5	9.1	8.3	
0:08 a. m.	49 00	1.32	1.432	.973	.767	.045	.046	.046	81.7	9.8	10.5	
0:11 p. m.	48 58	1.32	1.437	.978	.772	.029	.058	.044	82.0	8.4	10.3	Pc
2:29 p. m.	37 10	1.65	1.329	.922	.724	.033	.038	.036	79.5	6.0	7.7	
Mar. 25												
3:40 p. m.	25 09	2.35	.924	.665	.528	.084	.093	.088	62.9	15.5	6.3	Pc
4:23 p. m.	18 37	3.11	.792	.585	.475	.083	.108	.096	54.4	13.8	4.7	Tc aloft
Mar. 26												
2:41 a. m.	36 25	1.68	1.345	.946	.767	.049	.067	.058	75.8	7.0	7.8	
0:29 a. m.	49 18	1.31	1.489	1.019	.815	.027	.050	.038	83.1	6.7	9.9	Pc
0:02 a. m.	49 49	1.30	1.464	1.006	.805	.028	.048	.038	83.0	7.9	10.0	
3:23 p. m.	29 30	2.02	1.359	.947	.773	.031	.056	.044	74.7	5.0	6.0	
Mar. 27												
2:56 a. m.	34 06	1.78	1.390	.974	.802	.036	.074	.055	77.1	5.8	7.2	
0:29 a. m.	49 42	1.31	1.506	1.029	.823	.086	.050	.068	78.8	1.5	7.0	Pc
0:12 p. m.	50 08	1.30	1.498	1.032	.818	.062	.026	.044	82.1	5.2	9.5	
3:27 p. m.	29 12	2.05	1.305	.926	.749	.036	.051	.044	74.7	7.7	6.5	Pc
Mar. 29												
2:48 a. m.	35 38	1.71	1.136	.781	.619	.067	.095	.081	71.2	12.8	8.4	Pc
Mar. 30												
3:27 p. m.	29 59	2.00	1.266	.867	.696	.031	.062	.046	74.9	9.8	6.9	Tc aloft
5:13 p. m.	11 07	5.08	.690	.523	.424							

TABLE 4.

Date	Time	Number of particles per cubic centimeter	Visibility	Date	Time	Number of particles per cubic centimeter	Visibility
			Miles				*Miles*
Mar. 20.	9:30 a. m.	1,953	3	Mar. 22.	7 a. m.	1,712	3
Mar. 21.	9:30 a. m.	930	5	Mar. 25.	7 a. m.	1,124	5
Mar. 21.	5:20 p. m.	3,255	2	Mar. 26.	7 a. m.	452	2
Mar. 21.	8 p. m.	737	10	Mar. 27.	7 a. m.	1,364	1

Atmospheric conditions during solar radiation measurements, Blue Hill Observatory of Harvard University

Date and time from apparent noon	Air temperature	Wind (Beaufort scale)	Visibility (scale 0–10)	Sky blueness	Cloudiness and remarks
March 1935	°C.				
1; 0:28 a. m.	−2.8	SW 5	8–9	10	7 Ci, Cist, light haze.
3; 3:04 a. m.	+5.6	WNW 6	7	8	2 Frcu, Stcu, heavy water haze.
3; 1:42 a. m.	+3.9	WNW 7	8	9	Few Frcu. Light haze.
3; 1:44 p. m.	+3.9	NNW 6	9	------	2 Cu, Stcu.
3; 3:25 p. m.	+3.5	NW 7	9	9	Few Cu, Frcu, unusual visibility.
4; 0:51 a. m.	−2.8	NW 3	8	10	3 Cist, Ci, moderate haze.
8; 0:11 a. m.	−6.1	NxE 5	6–8	9	2 Frcu, Cu, Fum, heavy water haze.
8; 0:12 p. m.	−5.6	NNE 5	8	9	Cu, Fum, Frcu, heavy water haze.
8; 1:53 p. m.	−5.0	NNE 4	8–9	10	Few Cu, Frcu, light haze.
8; 3:18 p. m.	−5.0	NNE 3	8–9	10	Few Stcu, Cu, light haze.
8; 4:42 p. m.	−4.4	NE 3	9	11	Few Stcu, light haze.
9; 2:04 a. m.	−5.6	N 4	6–8	9	Few Ci, few Cu. Mod. to heavy haze.
9; 0:48 a. m.	−3.9	NE 3	7	10	No clouds, heavy haze.
9; 1:06 p. m.	−2.2	var 3	8–9	11	Few Ci, moderate haze.
13; 3:24 p. m.	+1.7	NWxW 6	8	8	7 Stcu, Cu, light haze.
14; 2:51 a. m.	−3.9	W 2	7–8	9	Few Ci, moderate haze.
14; 0:16 a. m.	−1.1	NW 2	8	9	5 Cist, 1 Acu, moderate haze.
16; 2:55 p. m.	+20.6	SW 5	7	9	2 Ci, moderate haze.
16; 3:23 p. m.	+21.1	WSW 5	7	9	2 Ci.
18; 2:59 a. m.	−6.1	NW 5	9	9	No clouds.
18; 0:05 a. m.	−0.6	NW 5	9	10	Few Ci, light haze.
20; 2:53 a. m.	+7.8	NW 4	7	9	2 Ci, 2 Cu, moderate haze.
20; 0:14 a. m.	+10.0	WNW 3	7	9	1 Acu, few Cu, heavy haze.
20; 2:55 p. m.	+13.3	WNW 4	7–8	9	Few Ci, heavy haze.
22; 2:35 a. m.	+7.2	NW 7	9	12	Few Frcu, no haze. Gusty, pyrh. vibrating.
22; 0:03 a. m.	+10.0	WNW 8	9–10	12	Few Frcu, Cu, no haze, rel. hum. 9%.
22; 3:17 p. m.	+11.1	WNW 8	9	11	Few Cu, light haze.
24; 2:50 a. m.	+4.4	NW 7	9	9	Few Frcu, moderate haze to W, gusty.

Atmospheric conditions during solar radiation measurements, Blue Hill Observatory of Harvard University—Continued

Date and time from apparent noon	Air temperature	Wind (Beaufort scale)	Visibility (scale 0–10)	Sky blueness	Cloudiness and remarks
March 1935	°C.				
24; 0:05 a. m.	+7.2	NW 6	9	11	Few Frcu, no haze.
24; 2:41 p. m.	+8.9	NW 5	9–10	10	Few Ci, few Cu, no haze, gusty.
25; 3:23 p. m.	+5.0	var 2 bec. NE.	8	8	Few Ci, few Cu, E wind below; variable smoke.
26; 2:59 a. m.	−2.2	NW 4	7–9	10	No clouds, moderate haze.
26; 0:18 a. m.	+1.7	NW 6	9	10	No clouds, slight haze, gusty.
26; 3:05 p. m.	+3.3	NW 6	9	10	Few Frcu, no haze, gusty.
27; 3:11 a. m.	−1.7	WNW 4	9	10	No clouds, light haze.
27; 0:04 a. m.	+5.0	WNW 6	9	10	No clouds, haze to W.
27; 2:32 p. m.	+8.9	WNW 4	8–9	9	Few Ci.
29; 2:45 a. m.	+3.9	WNW 4	7	6	Few Cu, heavy haze.
30; 1:16 p. m.	+4.4	WNW 6	8	9	1 Ci, few Cu.
30; 3:30 p. m.	+6.7	W 6	9	7	3 Ci, few Cu.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy, Superintendent U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1935	*h m*	°	°	°				
Mar. 1	11 6	−21.0	73.7	−18.0	------	93	93	U. S. Naval.
Mar. 2	12 20	−10.0	70.9	−18.0	------	93	93	Do.
Mar. 3	12 53	+4.0	71.4	−18.0	------	93	93	Do.
Mar. 4	11 18	+20.0	76.6	−17.0	222	------	222	Harvard.
Mar. 5	11 18	+30.0	71.9	−18.0	------	139	139	Mt. Wilson.
Mar. 6	11 13	+44.0	72.8	−18.0	77	------	77	U. S. Naval.
Mar. 7	10 6	+59.0	76.3	−17.0	100	------	100	Harvard.
Mar. 8	10 27	+73.0	76.3	−16.5	130	------	130	Do.
Mar. 9	11 10	−70.0	279.3	−17.0	------	123	------	U. S. Naval.
		+85.0	74.3	−18.5	31	------	154	
Mar. 10	12 12	−60.0	275.6	+2.0	62	------	------	Do.
		−56.0	279.6	−17.0	------	93	155	
Mar. 11	14 20	−48.0	273.3	+0.5	------	96	------	Mt. Wilson.
		−42.0	279.3	−18.0	------	41	------	
		+28.0	349.3	−28.0	------	4	------	
		+39.0	360.3	+22.0	------	25	166	
Mar. 12	11 0	−35.0	274.8	+0.5	------	171	------	Do.
		−29.0	280.8	−17.0	------	28	------	
		+39.0	348.8	−28.5	------	17	------	
		+54.0	363.8	+22.0	------	16	232	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
	h m	°	°	°				
Mar. 13	10 57	−22.0	274.7	+2.0		170		U. S. Naval.
		−17.0	279.7	−17.0		93		
		+51.0	347.7	−27.5		15		
		+67.0	363.7	+25.0		15	293	
Mar. 14	11 23	−70.0	213.3	+23.0	39			Do.
		−8.0	275.3	+1.5		139		
		−4.0	279.3	−16.5		108		
		+65.0	348.3	−27.0		77	363	
Mar. 15	11 6	−56.0	214.3	+22.5	62			Do.
		+4.5	274.8	+1.5		93		
		+9.0	279.3	−16.5		77	232	
Mar. 16	11 27	−40.0	216.9	+22.5		77		Do.
		+4.0	260.9	+30.0		93		
		+18.5	275.4	+1.0		62		
		+20.0	276.9	−15.5		62	294	
Mar. 18	11 24	−12.0	218.6	+22.5		23		Do.
		+30.0	260.6	+30.0		108		
		+48.0	278.6	+1.0	54		185	
Mar. 20	11 7	−68.0	136.4	−21.5		39		Do.
		+56.5	260.9	+31.0		93	132	
Mar. 21	13 15	−54.0	136.0	−21.0		62		Do.
		+70.0	260.0	+31.0		100	162	
Mar. 22	13 48	−39.0	137.5	−22.0		54	54	Do.
Mar. 23	10 45	−27.0	137.9	−22.0		32	32	Mt. Wilson.
Mar. 24	13 30	−17.0	133.3	−22.0		7	7	Do.
Mar. 25	11 5	−31.0	107.4	−34.0		9	9	Do.
Mar. 26	10 22	No spots						U. S. Naval.
Mar. 27	11 39	No spots						Do.
Mar. 28	10 45	No spots						Mt. Wilson.
Mar. 29	11 20	No spots						U. S. Naval.
Mar. 30	11 7	No spots						Do.
Mar. 31	9 15	No spots						Mt. Wilson.
Mean daily area for 29 days							118	

PROVISIONAL SUN-SPOT RELATIVE NUMBERS, MARCH 1935

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

March 1935	Relative numbers	March 1935	Relative numbers	March 1935	Relative numbers
1	19	11	*Wc* 34	21	25
2		12	44	22	17
3	*a* 20	13	56	23	12
4		14	*da* 72	24	8
5	17	15	*aa* 68	25	8
6	15	16	*Mc* 50	26	8
7	8	17	43	27	7
8	8	18	33	28	0
9	*d* 17	19	*Ec* 40	29	
10	*Ec* 27	20	35	30	0
				31	

Mean, 27 days=25.6

a=Passage of an average-sized group through the central meridian.
c=New formation of a center of activity: *E*, on the eastern part of the sun's disk; *W*, on the western part; *M*, in the central zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, in Charge]

By L. T. SAMUELS

Free-air temperatures during March averaged below normal at the western stations and above normal elsewhere, at stations where a sufficient period of previous record made it possible to determine departures. (See table 1.) The magnitudes of the departures ranged from moderate to large in most cases. The lowest average temperatures for the month occurred at the highest levels over the extreme Northwest. Free-air relative humidity departures were small in most cases, the largest being negative and occurring over San Diego.

The directions of the resultant winds for the month at 1,000 meters above sea level were close to the normal over the Pacific coast stations, but were more southerly than normal over the Plains States and southward from the Great Lakes. (See table 2.) A greater northerly component than normal occurred over Sault Ste. Marie and Boston. The velocities of the resultant winds at this level were mostly in excess of the normal, with greatest departures over Oklahoma City, Murfreesboro, and Key West.

At 3,000 meters the directions of the resultant winds were westerly as compared to the normal west-northwesterly, over the central and north-central sections. At Key West they were easterly as compared to the normal westerly. The velocities were generally above normal over the more northern sections and below normal over the southern sections.

At 5,000 meters there was an excess of northerly components as compared to the normal over the middle Pacific coast region, and an excess of southerly components over the more eastern Rocky Mountain stations. The velocities exceeded the normal resultants over the western Plateau, the lower Plains States, and the northeastern section of the country, with the largest departures over the extreme northern stations.

TABLE 1.—*Mean free-air temperatures and relative humidities obtained by airplanes during March 1935*

TEMPERATURE (°C.)

Stations	Altitude (meters) m. s. l.																Number of observations
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	
Billings, Mont.[1] (1,088 m)	−3.0						−0.8		−2.8		−6.3		−9.8		−16.4		−23.2		28
Boston, Mass.[2] (6 m)	1.0	0.0	0.0	+2.0	−0.9	+2.9	−2.0	+2.9	−3.5	+2.8	−5.7	+2.5	−8.0	+2.1	−13.7	+1.5	−19.2	+1.6	18
Cheyenne, Wyo.[1] (1,873 m)	−2.2								−1.5		−2.4		−5.1		−11.5		−18.3		30
Fargo, N. Dak.[1] (274 m)	−4.2		−4.0		−4.2		−5.0		−6.2		−8.4		−11.2		−17.4		−24.6		31
Kelly Field (San Antonio), Tex.[3] (206m)	14.9		16.0		15.7		14.7		12.9		11.4		8.4		1.3		−6.1		29
Lakehurst, N. J.[4] (3 m)	3.9		4.3		3.1		1.8		0.0		−2.5		−4.9		−11.1		−16.7		18
Maxwell Field (Montgomery), Ala.[3] (52 m)	13.1		14.2		13.2		11.3		9.2		6.4		3.7		−2.8		−8.9		27
Mitchel Field (Hempstead, L. I.), N. Y.[3] (29 m)	3.0		4.4		3.1		1.6		0.0		−2.3		−4.5		−9.9		−15.9		30
Murfreesboro, Tenn.[1] (174 m)	10.5		11.0		9.9		8.6		6.4		4.3		1.2		−5.3		−11.7		31
Norfolk, Va.[4] (10 m)	9.4	+2.4	9.4	+3.1	8.1	+3.7	6.0	+3.8	4.3	+4.2	2.8	+4.7	0.8	+4.9	−4.8	+4.8	−10.8	+4.8	27
Oklahoma City, Okla.[1] (391 m)	10.3		10.9		12.3		10.8		8.4		5.2		1.9		−5.5		−12.5		30
Omaha, Nebr.[1] (300 m)	2.6	+3.2	3.7	+3.7	5.1	+4.6	4.2	+4.3	2.1	+3.6	−1.0	+2.9	−4.3	+2.4	−11.0	+2.0	−17.9	+1.9	31
Pearl Harbor, Territory of Hawaii[4] (6 m)	19.2	−4.0	19.0	−1.2	15.9	−0.5	12.8	−0.8	10.9	−0.3	8.5	−0.8	5.8	−1.6	0.0	−2.8	−3.2	−2.8	28
Pensacola, Fla.[4] (24 m)	14.5	+2.6	15.3	+4.1	14.0	+4.6	12.2	+4.6	10.1	+4.4	8.9	+5.2	7.1	+5.5	2.3	+6.4	−4.1	+6.5	14
San Diego, Calif.[4] (10 m)	9.6	−4.7	9.3	−3.7	7.5	−4.7	6.1	−4.0	4.3	−3.6	2.5	−2.8	−0.1	−2.6	−5.8	−1.6	−13.3	−1.6	31
Scott Field (Belleville), Ill.[3] (135 m)	7.3		9.0		9.4		7.4		5.5		2.5		0.0		−6.4		−12.7		25
Seattle, Wash.[4] (25 m)	4.5	−4.7	2.7	−3.7	−0.4	−3.8	−3.8	−4.3	−7.3	−4.8	−10.6	−5.2	−13.6	−5.5	−20.0	−6.0	−27.3	−7.1	20
Selfridge Field (Mount Clemens), Mich.[3] (177 m)	0.2		1.2		1.5		0.3		−1.8		−3.7		−6.3		−12.1		−18.7		29
Spokane, Wash.[3] (596 m)	1.8				0.1		−2.5		−6.3		−9.4		−12.7		−19.3		−26.2		30
Sunnyvale, Calif.[4] (10 m)	8.0	−4.1	7.1	−2.7	5.2	−3.2	2.8	−3.8	0.9	−3.5	−2.1	−3.6	−4.9	−3.6	−10.6	−3.1	−16.6	−3.1	24
Washington, D. C.[4] (13 m)	6.9	+1.6	7.4	+3.6	6.0	+4.0	4.4	+4.5	3.1	+5.2	0.8	+4.9	−1.5	+4.6	−7.2	+4.6	−13.4	+4.6	25
Wright Field (Dayton), Ohio[3] (244 m)	5.9		5.7		5.9		4.2		2.5		0.3		−2.3		−8.4		−15.2		26

RELATIVE HUMIDITY (PERCENT)

Billings, Mont	69						60		57		61		63		59		52		
Boston, Mass	69	+1	65	−3	60	−5	56	−5	53	−6	51	−7	50	−5	47	−5	46	−4	
Cheyenne, Wyo	54								54		52		50		49		47		
Fargo, N. Dak	79		77		69		62		58		55		52		49		46		
Kelly Field (San Antonio), Tex	84		77		69		61		54		39		34		30		30		
Lakehurst, N. J	78		67		58		58		54		52		48		45		40		
Maxwell Field (Montgomery), Ala	81		69		61		52		48		44		42		39		39		
Mitchel Field (Hempstead, L. I.), N. Y	79		70		66		64		60		58		56		55		52		
Murfreesboro, Tenn	81		72		69		63		60		52		51		45		48		
Norfolk, Va	72	+5	67	+6	63	+5	62	+6	57	+4	51	+2	45	0	40	0	37	0	
Oklahoma City, Okla	76		73		57		48		42		39		37		38		38		
Omaha, Nebr	76	−2	70	−3	57	−5	49	−6	46	−6	46	−6	49	−4	54	0	55	+1	
Pearl Harbor, Territory of Hawaii	83	+14	78	+4	77	0	74	+2	63	−2	56	+1	45	+2	38	+11	37	+10	
Pensacola, Fla	88	+12	73	+6	67	+6	63	+6	60	+7	54	+4	49	+2	39	−2	34	−5	
San Diego, Calif	85	−14	79	−11	71	−16	59	−13	49	−11	42	−8	39	−8	36	−8	39	−8	
Scott Field (Belleville), Ill	80		66		55		52		48		48		46		43		47		
Seattle, Wash	80	+10	79	+9	77	+9	74	+8	73	+9	69	+10	64	+10	60	+9	60	+10	
Selfridge Field (Mount Clemens), Mich	82		72		62		57		50		42		44		40		38		
Spokane, Wash	72				71		68		67		67		67		63		62		
Sunnyvale, Calif	83	+8	70	−1	65	+2	61	+7	56	+8	52	+7	47	+5	42	+4	40	+4	
Washington, D. C	70	+3	64	0	63	+1	64	+4	61	+3	56	+2	51	+1	47	0	44	0	
Wright Field (Dayton), Ohio	73		71		61		61		52		47		41		36		37		

[1] Weather Bureau. [2] Massachusetts Institute of Technology. [3] Army. [4] Navy. [5] National Guard.

Observations taken about 5 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—The departures are based on "normals" covering the following total number of observations: Boston, 70; Pearl Harbor, 101; Pensacola, 125; Sunnyvale, 52; Omaha, 123; Washington, 187; Norfolk, 129; San Diego, 152; Seattle, 52.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 6 a. m. (E. S. T.) during March 1935*

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (153 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (274 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Murfreesboro, Tenn. (180 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	337	1.3	241	1.1	265	2.4	296	2.7	271	4.8	176	0.3	283	0.9	268	1.4	231	1.5	111	1.2	97	3.1	202	0.3	198	2.2
500	-----	-----	253	3.1	-----	-----	302	7.2	-----	-----	231	3.2	230	4.1	276	2.9	233	3.3	174	5.3	108	6.8	212	0.6	222	7.2
1,000	-----	-----	258	6.1	-----	-----	298	9.4	-----	-----	256	8.1	267	7.4	288	5.4	258	5.2	218	5.6	121	6.0	238	1.7	246	11.5
1,500	-----	-----	265	7.9	257	9.3	300	12.3	-----	-----	264	9.6	274	6.4	282	8.3	282	7.3	220	7.7	128	4.1	236	3.2	257	10.8
2,000	276	3.8	273	8.4	269	9.7	297	12.3	271	6.7	272	10.4	263	5.9	282	8.3	274	9.0	236	7.1	133	3.8	249	4.4	266	9.3
2,500	273	6.3	267	8.5	273	10.1	289	13.1	272	13.3	280	10.5	271	8.7	281	10.1	275	11.0	239	7.0	121	2.9	269	5.4	268	10.6
3,000	266	7.8	271	9.6	274	11.2	288	14.5	276	13.8	277	10.3	279	6.3	276	11.5	292	11.6	262	7.2	98	2.8	286	6.2	255	10.3
4,000	267	12.4	281	11.6	268	14.2	299	24.6	267	16.0	235	11.8	-----	-----	268	15.2	254	10.3	255	7.1	54	2.7	305	10.7	270	8.0
5,000	255	14.1	-----	-----	246	10.2	292	25.0	248	11.0	-----	-----	-----	-----	282	11.8	270	12.0	279	9.9	14	3.4	316	13.4	-----	-----

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 6 a. m. (E. S. T.) during March 1935*—Continued

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Harbor, Territory of Hawaii [1] (68 m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	320	1.2	156	0.7	178	2.9	134	1.0	34	1.4	81	1.4	197	1.5	168	3.6	15	0.4	330	0.2	178	3.3	157	0.9	194	0.9
500	292	4.4	281	2.4	198	6.6	193	1.3	67	2.4	189	3.2	215	4.5	----	----	280	1.7	360	0.9	202	6.0	----	----	231	6.2
1,000	293	8.6	305	3.3	235	11.5	256	4.7	86	0.8	206	4.1	253	8.6	----	----	289	2.7	286	2.6	195	4.8	226	4.4	256	7.6
1,500	285	11.7	296	4.0	245	11.3	268	6.8	216	2.3	231	4.3	261	8.3	174	5.0	282	2.8	303	4.1	221	3.8	235	6.1	267	10.2
2,000	280	15.0	297	4.8	256	11.3	276	8.6	230	3.4	242	4.3	262	10.0	199	5.3	262	3.3	289	7.0	259	2.6	244	6.9	268	11.5
2,500	282	13.0	304	5.5	263	12.1	271	9.8	261	3.6	227	3.7	279	9.4	235	4.9	464	4.1	287	8.6	297	3.3	249	6.2	267	11.1
3,000	299	11.2	321	6.2	274	9.3	261	10.9	242	3.6	261	3.6	298	12.1	264	6.3	275	4.0	277	9.5	299	4.3	270	7.6	295	12.3
4,000	----	----	323	10.4	312	11.9	234	15.4	207	6.3	242	5.1	274	12.8	273	10.1	275	5.8	290	14.5	306	8.7	298	7.4	323	16.3
5,000	----	----	318	5.8	298	11.0	----	----	----	----	----	----	----	----	290	10.5	64	2.3	270	25.0	----	----	302	13.2	----	----

[1] Navy stations.

RIVERS AND FLOODS

[River and Flood Division, MONTROSE W. HAYES, in charge]

By RICHMOND T. ZOCH

There were numerous overflows in the rivers of the eastern half of the United States during March 1935. Fortunately, most of these overflows were of minor consequence.

The Tombigbee and Black Warrior Rivers reached high stages; but relatively little damage resulted, since little planting had been done.

In the Pearl and Pascagoula River systems severe floods occurred. Heavy rains fell over these watersheds from the 4th to the 7th, and light to moderate rains continued through the 12th. These rains caused flood stages at every gage station on these rivers, with severe flood conditions in the Pearl River above Columbia, Miss., and in the Chickasawhay and Leaf Rivers. Jackson, Miss., suffered more than any other locality in these watersheds; at Jackson the water reached a stage of 35.2 feet, which was within 2 feet of the highest stage of record and exactly equal to the crest stage of the December 1932, flood. However, because of the fact that this recent flood was in spring rather than in winter, the losses were considerably greater. Timely warnings were issued for these floods. Reports from the various interested people and organizations after the subsidence of the floods indicate that the warnings were more generally heeded than ordinarily, and resulted in an unusually large saving of property and livestock. Lumber companies, especially, made good use of the warnings, and moved large amounts of logs and lumber to higher ground, in addition to moving equipment out of the swamps and lowlands.

High water occurred in the upper Mississippi River, but flood stage was not reached at any gage station. However, apprehension was felt because of the dams under construction there. When the Weather Bureau advised that high water would occur, the cofferdams were reinforced, and no damage was caused to any of the construction projects on the locks and dams.

A very high flood occurred in the Meramec River in Missouri. Notwithstanding the unusually high water, flood losses were not very large. The flood, coming early in the spring, caused much less damage to crops than it would have caused a month or two later.

An ice gorge formed in the Missouri River about 5 miles below Sioux City, Iowa, on the night of the 6–7th. The gorge caused some apprehension, but as the river was low only slight damage resulted.

The flood in the Ohio River was not of serious proportions, and the damage was comparatively small.

In Arkansas and southern Missouri, there were severe floods in the White and St. Francis River systems. At Poplar Bluff, Mo., on the Black River, Georgetown, Ark., on the White River, and Fisk, Mo., and St. Francis, Ark., on the St. Francis River, the flood waters reached higher stages than ever previously recorded.

Several breaks occurred in the St. Francis River levees. In all, 62 breaks occurred, varying in width from 40 to 400 feet. It is estimated that 175,000 acres of land were flooded by the St. Francis flood; the flooded area was situated in Butler, Stoddard and Dunklin Counties of Missouri, and Clay, Greene, Craighead, and Mississippi Counties of Arkansas. Many farmers fled, abandoning household goods, livestock, etc. Four companies of the Missouri National Guard were called out and sent to the flooded area to preserve order and assist the flood-stricken people. The Red Cross assisted 25,000 flood refugees. Four persons were drowned.

Comments on the floods in the Yazoo and Tallahatchie Rivers in Mississippi, and in the Lower Mississippi River and Green River in Kentucky, will be made in a later issue of the MONTHLY WEATHER REVIEW.

Besides the floods in the streams where flood service is maintained, there were severe local floods in small streams as follows:

In the upper Tug Valley of West Virginia there was an unprecedented flood. The railroad between Bluefield and Welch was out of service for over 2 weeks, and much damage was done to highways.

At Sebewaing, Mich., on the Sebewaing River, there was an ice gorge that caused flooding with much damage to property.

The melting of the heavy snow cover in the northern portion of Wisconsin caused rapidly rising waters in all the small streams of that state from the 22d to 25th. Attendant ice gorges caused many overflows, with considerable damage to highways.

Table of flood stages in March 1935

[All dates in March unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ST. LAWRENCE DRAINAGE					
	Feet			*Feet*	
Grand: Grand Rapids, Mich.	11	7	8	11.2	7
Flint: Columbiaville, Mich.	8	6	7	10.3	7
		11	12	9.2	12
Cass:					
Vassar, Mich.	13	6	6	14.7	6
Bridgeport, Mich.	15	7	7	16.8	7
Pine: Alma, Mich.	6	5	6	9.4	5
		12	13	6.4	13
		17	20	7.9	18
Tittabawassee: Shields, Mich.	10	7	9	12.4	8
		11	13	11.3	13
		17	24	14.1	19
ATLANTIC SLOPE DRAINAGE					
Mohawk: Tribes Hill, N. Y.	23	7	7	25.0	7
Susquehanna:					
Oneonta, N. Y.	12	7	7	12.6	7
Bainbridge, N. Y.	11	7	7	11.9	7
James:					
Columbia, Va.	10	13	17	18.8	13
		26	30	16.3	27
Richmond, Va.	8	14	15	9.0	14
Roanoke:					
Randolph, Va.	18	14	14	22.4	14
Weldon, N. C.	31	14	16	37.0	15
		28	29	34.8	28
Williamston, N. C.	10	19	(1)	10.9	21
Tar: Greenville, N. C.	12	29	(1)	12.8	31
Neuse:					
Neuse, N. C.	13	14	14	13.3	14
		27	29	14.5	28
Smithfield, N. C.	12	14	16	13.5	14
		27	30	14.8	29
Cape Fear: Lock No. 2, Elizabethtown, N. C.	20	1	2	22.0	1
		14	17	25.6	15
		27	30	25.3	28
Peedee:					
Cheraw, S. C.	30	14	15	32.8	15
		27	28	35.1	27
Mars Bluff Bridge, S. C.	17	16	21	18.9	18
		29	(1)	(1)	(1)
Poston, S. C.	18	21	23	18.0	21–23
Saluda:					
Pelzer, S. C.	6	12	12	9.0	12
Chappells, S. C.	13	13	14	16.0	14
Broad: Blairs, S. C.	14	13	14	15.7	14
Catawba: Catawba, S. C.	11	13	13	11.0	13
Wateree: Camden, S. C.	24	14	14	24.0	14
Santee:					
Rimini, S. C.	12	2	2	12.0	2
		14	24	13.8	17
Ferguson, S. C.	12	16	25	13.5	20
Savannah: Ellenton, S. C.	14	14	20	20.8	16
Ocmulgee: Macon, Ga.	18	13	13	18.6	13
Altamaha: Charlotte, Ga.	12	23	23	12.1	23
EAST GULF OF MEXICO DRAINAGE					
Apalachicola: Blountstown, Fla.	15	9	13	17.8	11
		15	20	17.8	17
Coosa: Gadsden, Ala.	20	14	15	20.5	14
Cahaba: Centerville, Ala.	23	7	7	28.0	7
Alabama:					
Montgomery, Ala.	30	9	10	31.0	9
		14	16	31.2	15
Selma, Ala.	35	9	12	36.8	10
		15	16	35.5	16
Millers Ferry, Ala.	40	10	18	43.7	13
Black Warrior: Lock No. 10, Tuscaloosa, Ala.	46	6	9	58.8	7
		13	15	54.5	14
Tombigbee:					
Aberdeen, Miss.	34	13	15	34.6	14
Lock No. 4, Demopolis, Ala.	39	7	28	59.2	18–19
Lock No. 3, Ala.	33	6	(1)	58.5	19
Lock No. 2, Ala.	46	7	29	59.7	20
Lock No. 1, Ala.	31	6	(1)	41.0	23
Leaf: Hattiesburg, Miss.	18	8	11	22.8	9
Chickasawhay:					
Enterprise, Miss.	20	6	10	30.6	8
Shubuta, Miss.	26	7	16	37.6	10
Pascagoula: Merrill, Miss.	22	9	20	25.9	13
Bogue Chitto: Franklinton, La.	12	8	9	13.8	8
Pearl:					
Edinburg, Miss.	20	6	17	26.2	8
Jackson, Miss.	18	5	27	35.2	12
Monticello, Miss.	15	6	28	26.3	16
Columbia, Miss.	17	7	29	24.9	18
Pearl River, La.	12	9	(1)	16.2	22

Table of flood stages in March 1935—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
	Feet			*Feet*	
Chippewa: Durand, Wis.	11	24	27	12.7	25
Wisconsin:					
Knowlton, Wis.	12	22	28	18.9	22
Wisconsin Rapids, Wis.	12	24	25	14.1	24
Portage, Wis.	17	25	31	19.0	27
Rock: Moline, Ill.	10	2	2	10.5	2
		7	9	10.4	8
		12	22	11.0	15
Iowa:					
Iowa City, Iowa	8	9	12	9.8	11
Wapello, Iowa	10	11	13	11.0	12
Illinois:					
Peru, Ill.	17	11	17	18.1	12
		22	30	18.0	26–27
Peoria, Ill.	18	13	Apr. 3	18.85	28
Havana, Ill.	14	Feb. 26	(1)	16.1	28–31
Beardstown, Ill.	14	Feb. 27	(1)	16.6	17–20
Bourbeuse: Union, Mo.	12	12	14	14.8	13
Meramec:					
Pacific, Mo.	11	12	16	22.6	14
Valley Park, Mo.	14	12	16	27.8	14
Ohio Basin					
Monongahela:					
Lock No. 15, Hoult, W. Va.	22	12	12	24.2	12
Lock No. 7, Greensboro, Pa.	30	12	13	34.3	12
Lock No. 4, Pa.	30	12	13	32.1	13
Little Kanawha:					
Glenville, W. Va.	23	12	13	25.5	12
Creston, W. Va.	20	12	13	23.4	12
Gauley: Summersville, W. Va.	10	12	13	13.9	12
		24	24	13.7	24
Licking: Farmers, Ky.	25	13	13	25.67	13
North Fork:					
Hazard, Ky.	20	12	12	22.3	12
Jackson, Ky.	28	12	13	36.0	13
Kentucky:					
Lock No. 7, High Bridge, Ky.	30	12	15	33.2	12
Lock No. 4, Frankfort, Ky.	31	13	16	33.3	13
Barren: Bowling Green, Ky.	20	12	16	29.9	14
		27	30	23.3	29
Green:					
Lock No. 6, Brownsville, Ky.	28	12	17	41.5	14
			20	46.1	15
Lock No. 4, Woodbury, Ky.	33	12			
		27	(1)	38.6	29
Lock No. 2, Rumsey, Ky.	34	12	(1)	42.5	21
West Fork: Edwardsport, Ind.	12	13	16	15.4	14
		26	27	14.2	27
White:					
Petersburg, Ind.	16	14	17	16.9	16
		27	29	18.1	28
Hazleton, Ind.	16	14	18	17.5	16
		27	31	18.4	29
Wabash:					
Terre Haute, Ind.	14	13	13	14.0	13
Mount Carmel, Ill.	16	14	19	17.6	17
		29	30	16.3	30
Cumberland:					
Williamsburg, Ky.	19	13	14	23.05	13
Burnside, Ky.	50	13	13	50.6	13
Celina, Tenn.	28	12	18	43.7	16
		26	(1)	40.4	29
Carthage, Tenn.	40	14	16	42.0	15
Nashville, Tenn.	40	16	20	41.9	18
Clarksville, Tenn.	46	14	21	47.2	20
Lock F, Eddyville, Ky.	50	14	29	57.9	22
		31	(1)	(1)	(1)
North Fork: Mendota, Va.	8	26	26	9.9	26
South Fork: Bluff City, Tenn.	12	26	26	12.5	26
Holston: Rogersville, Tenn.	13	26	27	18.5	27
Newport, Tenn.	6	12	12	6.5	12
		25	25	6.0	25
Nolichucky: Embreeville, Tenn.	8	26	26	10.8	26
French Broad:					
Oldtown, Tenn.	6	26	26	9.1	26
Dandridge, Tenn.	12	26	27	16.6	26
Little Tennessee: McGhee, Tenn.	18	13	13	18.3	13
Clinch: Clinton, Tenn.	26	27	27	27.5	27
Elk: Fayetteville, Tenn.	14	12	15	18.5	14
Tennessee:					
Knoxville, Tenn.	20	26	28	23.7	27
Bridgeport, Ala.	18	14	17	21.0	15
		29	30	19.7	30
Widow's Bar Dam, Ala.	26	14	17	29.6	16
		29	31	28.2	30
Guntersville, Ala.	25	15	18	29.0	17
		31	Apr. 1	26.3	31
Riverton Lock, Ala.	33	13	20	36.8	17

Table of flood stages in March 1935—Continued

River and station	Flood stage	Above flood stages—dates From—	To—	Crest Stage	Date
Ohio:	*Feet*			*Feet*	
Pittsburgh, Pa.	25	12	13	26.3	13
Dam No. 6, Beaver, Pa.	30	13	14	31.9	13
Dam No. 25, near Addison, Ohio	43	15	16	46.8	14
Point Pleasant, W. Va.	40	13	16	43.6	14
Dam No. 26, near Chambersburg, Ohio	50	15	15	50.0	15
Dam No. 29, near Ashland, Ky.	50	14	16	53.9	14
Dam No. 30, near Greenup, Ky.	52	14	16	53.7	15
Portsmouth, Ohio	50	15	16	51.1	15
Dam No. 33, near Maysville, Ky.	50	15	16	51.1	16
Dam No. 35, New Richmond, Ohio	48	16	17	48.4	16
Cincinnati, Ohio	52	16	17	52.4	16
Dam No. 37, Fernbank Ohio	50	16	18	51.6	16
Dam No. 38, near Grant, Ky.	51	17	17	51.0	17
Madison, Ind.	46	17	17	46.0	17
Dam No. 41, Louisville, Ky.	51	16	19	52.9	18
Dam No. 43, Evans Landing, Ind.	55	16	19	57.8	18
Dam No. 44, Leavenworth, Ind.	50	15	21	57.6	18
Dam No. 45, Addison, Ky.	47	16	20	50.3	18
Dam No. 46, Owensboro, Ky.	41	17	21	42.4	19
Dam No. 47, Newburgh, Ind.	38	13	24	45.0	19
		29	(1)	(1)	(1)
Evansville, Ind.	35	13	25	42.9	20
		28	(1)	(1)	(1)
Dam No. 48, near Henderson, Ky.	38	14	25	44.8	20
		31	(1)	(1)	(1)
Dam No. 49, near Uniontown, Ky.	37	15	28	44.1	22
		30	(1)	(1)	(1)
Dam No. 50, Fords Ferry, Ky.	34	13	(1)	47.1	22
Dam No. 51, Golconda, Ill.	40	16	27	45.0	22
Dam No. 52, Brookport, Ill.	37	13	(1)	47.3	23
Dam No. 53, near Mound City, Ill.	42	12	(1)	52.1	23
Cairo, Ill.	40	12	(1)	49.9	23
White Basin					
Black:					
Leeper, Mo.	11	11	12	18.8	11
Poplar Bluff, Mo.	14	11	15	19.1	12
Black Rock, Ark.	14	11	(1)	26.7	12
White:					
Cotter, Ark.	21	12	14	35.2	13
Calico Rock, Ark.	18	11	15	41.8	12
		25	26	19.9	25
Batesville, Ark.	23	11	16	38.6	13
		25	28	26.7	25
Newport, Ark.	26	13	Apr. 1	33.7	14
Georgetown, Ark.	21	13	(1)	31.3	18
Clarendon, Ark.	26	16	(1)	33.7	26
Arkansas Basin					
Neosho: Fort Gibson, Okla.	22	13	14	24.0	13
		5	8	22.8	6
Petit Jean: Danville, Ark.	20	11	15	26.2	12
		22	26	26.7	23

Table of flood stages in March 1935—Continued

River and station	Flood stage	Above flood stages—dates From—	To—	Crest Stage	Date
Arkansas:	*Feet*			*Feet*	
Webbers Falls, Okla.	23	13	14	24.5	13
Fort Smith, Ark.	22	13	15	25.4	14
		25	27	24.1	26
Van Buren, Ark.	22	13	15	25.4	14
		25	27	24.0	26
Ozark, Ark.	22	15	15	22.1	15
Dardanelle, Ark.	22	15	15	22.5	15
Morrilton, Ark.	20	14	16	21.6	15
		26	28	22.3	27
Red Basin					
Ouachita:					
Arkadelphia, Ark.	17	5	5	13.2	12
		12	13	19.6	12
Camden, Ark.	26	15	19	29.0	16
Sulphur:					
Ringo Crossing, Tex.	20	5	7	23.2	5
Naples, Tex.	22	10	15	23.6	12
Lower Mississippi Basin					
Big Lake Outlet: Manila, Ark.	10	Jan. 3	2	16.8	Jan. 28–29
		10	(1)	19.4	22–24
St. Francis:					
Fisk, Mo.	20	11	18	27.0	12
St. Francis, Ark.	18	11	(1)	28.2	15
St. Francis Lock, Ark.	27	21	(1)	29.2	25–27
Parkin, Ark.	28	30	(1)	(1)	(1)
Madison, Ark.	32	29	(1)	(1)	(1)
				34.1	Jan. 31
Tallahatchie: Swan Lake, Miss.	26	Jan. 10	(1)	31.6	17
Yazoo:					
Greenwood, Miss.	35	16	24	35.6	20
Yazoo City, Miss.	29	5	(1)	(1)	(1)
Mississippi:					
New Madrid, Mo.	34	13	(1)	39.9	23–24
Memphis, Tenn.	34	21	(1)	37.2	28
Helena, Ark.	39	18	(1)	(1)	(1)
Arkansas City, Ark.	42	22	(1)	(1)	(1)
Greenville, Miss.	36	23	(1)	(1)	(1)
Atchafalaya Basin					
Atchafalaya: Atchafalaya, La.	22	15	(1)	(1)	(1)

[1] Continued into April.

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDONALD in Charge]

NORTH ATLANTIC OCEAN, MARCH 1935

By H. C. HUNTER

Atmospheric pressure.—From Maine to Iceland and the Azores the average pressure for March was moderately subnormal with the maximum deficiency, about 0.20 inch, over Davis Strait. Elsewhere over the North Atlantic and adjacent shores the pressure averaged higher than normal, the greatest excess, 0.33 inch, occurring over the Shetlands, and pressures 0.10 or less above normal over the eastern United States. The period from 9th to 11th was marked by especially high pressure over substantially all the ocean north of 30° latitude, except near southern Greenland.

The highest reported reading from a vessel was 30.71 inches on the 12th by the American steamship *Cliffwood*, when a short distance northwest of Scotland. The station at Lerwick, Shetland Islands, noted still higher pressures daily from the 9th to the 12th, while some coast stations of Norway had higher than 30.90 inches on the 9th.

The lowest reading noted by a vessel was 28.51 inches, on the American steamship *Quaker City*, at 3 p. m. the 17th, in latitude 55° N., longitude 28° W.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, March 1935*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.50	.....	30.00	26	28.99	7
Reykjavik, Iceland	29.67	−0.01	30.30	11	28.87	1
Larwick, Shetland Islands	30.03	+.33	30.88	9	29.28	23
Valencia, Ireland	30.11	+.21	30.54	12	29.17	1
Lisbon, Portugal	30.11	+.11	30.41	3	29.76	15
Madeira	30.10	+.09	30.43	1	29.83	26
Horta, Azores	30.09	−.09	30.45	1	29.79	17
Belle Isle, Newfoundland	29.61	−.19	30.14	9	28.88	26
Halifax, Nova Scotia	29.91	−.05	30.46	9	29.24	24
Nantucket	30.00	+.05	30.64	9	29.31	13
Hatteras	30.12	+.08	30.59	9	29.46	26
Bermuda	30.17	+.03	30.46	10	29.54	26
Turks Island	30.10	+.08	30.17	11	29.93	26
Key West	30.10	+.05	30.39	1	29.86	27
New Orleans	30.08	+.04	30.51	1	29.69	12

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—Gales were numerous, though not so many as in each of the 3 next preceding months. Only 1 report of force 12 during March has come to hand, and only 7 of force 11.

Several ships encountered gales in the waters southwest of Ireland on the 1st. The British steamship *Jamaica Producer* recorded force 11. Thereafter conditions were less stormy until the 8th, when the high-pressure area over northwestern Europe showed increased strength and another strong anticyclone was nearing the lower Lakes in its southeastward movement toward the North Atlantic coast. Between these areas pressure was decidedly low south of Cape Farewell and rather low north of Bermuda. Several whole gales and a wind of force 11 were noted near mid-ocean on the 8th to 11th. The LOW from near Bermuda was by the 11th near the thirty-fifth meridian, while another LOW had begun to affect the west Gulf region.

On the 12th (chart IX) low-pressure centers were near the Atlantic coast of the United States and near and to southward of southern Greenland, while high pressure extended from Bermuda to Madeira and thence northeastward to Norway. Strong winds were noted this day in many parts of the ocean where the gradient was steep; one instance of force 11 was reported by the Dutch motorship *Tanimbar*, close to 42° N., 40° W.

Only a few gales were recorded on the 14th and 15th, but on the 16th the British motorship *Irisbank* noted force 11 east-northeast of Bermuda.

Chart X shows the conditions of the 18th, when decidedly low pressure extended from Newfoundland eastward to within 400 miles of Ireland. Several instances of forces 9 to 11 were noted on or about this day, and the single instance of hurricane force (12) was recorded during the afternoon of the 17th, by the American steamship *Quaker City* which also reported the lowest pressure of the month, as noted above.

After the 19th few gales of importance occurred east of the fortieth meridian and except during the 4-day period, 24th to 27th, not many elsewhere. Decidedly low pressure was persistent during the latter period in the general region of Nova Scotia and Newfoundland, causing strong winds, almost invariably from a southerly or westerly point, along the chief routes, mainly between the sixty-fifth and forty-fifth meridians. The French liner *Paris* recorded force 11 from the west at an early hour of the 25th, near 42° N., 51° W.

About the 8th and 9th, when pressure was notably high near Bermuda and Hatteras, there were several reports of gales from a northwesterly or northerly direction, by vessels near the thirtieth parallel of latitude, between the Florida coast and the fifty-fifth meridian. The American steamship *Solana* noted force 10 in this region.

Trade winds of much greater force than usual were noted in the Caribbean Sea on the 2d and 12th.

Fog.—There was more fog than there had been during February in some areas near the Gulf and Atlantic coasts of the United States, in parts of the Grand Banks region, and especially in and near the English Channel. In this last-named region fog was decidedly more prevalent than usual in March, as it was likewise near Delaware and Chesapeake Bays, and in the northwestern Gulf of Mexico.

In other North Atlantic regions the fog situation was not far from normal, save from the waters adjacent to New England eastward nearly to the Grand Banks, where there was less fog than would be expected.

The chief period of fog in waters bordering on England and northwestern France was the 18th to 21st; also the English Channel had considerable from the 26th to 29th. The Grand Banks region noted widespread fog about the 3d and for a period of fully a week near the middle of the month. The 5° square from 40° to 45° N., 45° to 50° W., reported fog altogether on nine different days of the month.

Over the waters adjacent to Nova Scotia and New England there were scattered occurrences of fog during the first week and about the 12th. Near Delaware and Chesapeake Bays fog occurred chiefly about the 6th, 12th, 20th, and 31st, and in the square 35° to 40° N., 70° to 75° W., there were 9 days during March on which fog was noted.

From Cape Hatteras to southern Florida and in the northeastern Gulf of Mexico fog was very seldom met, but it was quite otherwise in the northwestern part of the Gulf. The waters in the square 25° to 30° N., 90° to 95° W., experienced fog from the 6th to 9th, and again from the 21st to 23d, 7 days altogether.

OCEAN GALES AND STORMS, MARCH 1935

Vessel	Voyage		Postition at time of lowest barometer		Gale began March —	Time of lowest barometer March —	Gale ended March —	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
City of Hamburg, Am. S. S.	Norfolk	London	49 12 N.	20 57 W.	1	4a, 1	1	29.30	SW	SW, 8	WNW	W, 9	SW-W.
Jamaica Producer, Br. S. S.	Kingston	Rotterdam	48 50 N.	16 00 W.	[1] 26	8a, 1	1	29.33	WNW	W, 8	NW	WNW, 11	W-NNW.
Mercier, Belg. S. S.	Antwerp	New York	49 46 N.	13 08 W.	1	9a, 1	1	29.32	WSW	WSW, 8	WNW	WNW, 10	W-WSW-WNW.
General Gassouin, Fr. M. S.	New York	Antwerp	49 26 N.	10 04 W.	1	10a, 1	2	29.06	W	W, 8	NW	W, 9	W-NW.
Bodegraven, Du. S. S.	Cristobal	Liverpool	11 26 N.	74 50 W.	1	4p, 2	6	29.71	NE	NE, 8	E	NE, 8	None.
Leerdam, Du. S. S.	Chester, Pa.	Rotterdam	39 32 N.	68 32 W.	3	8a, 3	5	30.04	NNW	SW, 4	N	NW, 10	SW-NW.
London Corporation, Br. S. S.	Halifax	Liverpool	43 00 N.	57 00 W.	4	3a, 4	6	29.51	S	W, 9	W	W, 10	S-W.
Frode, Dan. S. S.	Emmingham, Eng.	Halifax	44 49 N.	52 17 W.	4	9a, 4	5	29.29	W	W, 6	WNW	W, 10	WSW-W.
Maine, Dan. S. S.	New York	Copenhagen	55 30 N.	26 15 W.	5	Mdt, 5	7	29.62	SSE	S, 9	SSE	S, 10	
Sandown Castle, Br. S. S.	London	New York	49 15 N.	24 45 W.	6	3p, 6	6	29.60	S	SSW, 9	SW	S, 10	S-SSW-W.
Lustrous, Br. S. S.	Falmouth, Eng.	Port Arthur	42 10 N.	25 20 W.	6	4p, 6	6	29.68	SSE	SW, 6	W	S, 10	S-WSW.
Steelmaker, Am. S. S.	Cristobal	London	39 34 N.	36 05 W.	5	4a, 7	7	29.54	WSW	WSW, 8	W	NW, 9	SW-W.
Solana, Am. S. S.	New Orleans	New York	30 30 N.	79 15 W.	8	7a, 8	9	30.06	NE	W, 4	NE	NE, 10	W-NNW.
London Corporation, Br. S. S.	Halifax	Liverpool	49 28 N.	23 20 W.	8	8a, 9	10	29.47	SE	SE, 11	SE	SE, 11	Steady.
Leerdam, Du. S. S.	Chester, Pa.	Rotterdam	48 32 N.	26 00 W.	8	10a, 9	10	29.16	S	SE, 9	SE	SE, 9	SSE-W-N.
Excelsior, Am. S. S.	Casablanca	New York	37 00 N.	41 56 W.	9	6a, 10	10	29.37	SSW	SW, 8	WNW	WNW, 9	SSW-W.

[1] February.

OCEAN GALES AND STORMS, MARCH 1935—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began March —	Time of lowest barometer March —	Gale ended March —	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN—Continued			° ′	° ′				*Inches*					
West Eldara, Am. S. S.	Newport News	Rotterdam	[1]46 56 N.	34 30 W.	11	2p, 10	11	28.94	S	S, 7	SW	S, 9	ENE-S.
Tanimbar, Du. M. S.	Gibraltar	Halifax	41 18 N.	33 59 W.	10	6a, 11	11	29.47	S	WSW, 10	W	WSW, 10	SW-W.
Sagaporack, Am. S. S.	Copenhagen	Portland, Maine.	56 00 N.	24 30 W.	11	2a, 12	12	29.32	SSE	SE, 10	S	SE, 10	SE-S-W.
Tillie Lykes, Am. S. S.	Puerto Colombia.	Santo Domingo.	11 39 N.	74 37 W.	11	4a, 12	13	29.78	ENE	NE, 7	E	ENE, 7	None.
Tetela, Br. S. S.	Pto. Cortez, Hond.	Rotterdam	44 50 N.	40 38 W.	12	10a, 12	12	29.30	SSE	SE, 8	N	NNE, 9	SSE-SE-WSW.
Tanimbar, Du. M. S.	Gibraltar	Halifax	41 44 N.	40 18 W.	12	Noon, 12	12	29.60	S	WSW, 9	NNW	SW, 11	SW-W.
Barbara, Am. S. S.	San Juan	Philadelphia	34 02 N.	73 40 W.	12	2a, 13	13	29.61	SW	SW, 9	NW	SW, 9	SW-NW.
General Gassouin, Fr. M. S.	Antwerp	New York	42 07 N.	26 15 W.	13	3p, 13	13	29.55	SW	WSW, 7	WSW	SW, 10	SW-WNW.
Black Falcon, Am. S. S.	do	do	49 35 N.	23 15 W.	15	5a, 15	16	29.08	WNW	SSW, 7	W	W, 9	SSW-W.
Irisbank, Br. M. S.	Gibraltar	Boston	35 30 N.	50 50 W.	15	4a, 16	16	29.86	SSW	NW, 10	NNW	NW, 11	WSW-NW.
Quaker City, Am. S. S.	Dundee	do	54 45 N.	27 08 W.	17	3p, 17	17	28.51	NE	N, 12	NW	N, 12	NE-N-NW.
Irisbank, Br. M. S.	Gibraltar	do	38 05 N.	61 50 W.	18	7a, 18	18	30.15	SW	SW, 11	NW	SW, 11	SW-NW.
Manhattan, Am. S. S.	Cobh	New York	45 12 N.	38 30 W.	18	9a, 18	19	29.53	NW	NW8	WNW	W, 10	W-NW.
New York, Ger. S. S.	Cherbourg	do	47 00 N.	31 36 W.	19	10a, 18	22	29.21	SW	NNE, 4	WNW	W, 11	
Alkmaar, Du. S. S.	Amsterdam	Curacao	40 58 N.	21 25 W.	18	10p, 18	19	29.46	SW	WNW, 9	NW	NW, 10	SW-NW.
Stuttgart, Ger. S. S.	Galway	Halifax	48 00 N.	32 54 W.	20	10p, 19	21	[2]29.49	WSW	SW, 7	WSW	W, 10	
Scanstates, Am. S. S.	Copenhagen	New York	52 12 N.	35 06 W.	20	10a, 20	21	28.98	W	SW, 7	NW	NNW, 9	SW-W.
Brasilien, Dan. S. S.	Buenos Aires	Copenhagen	37 52 N.	12 46 W.	19	Noon, 20	20	[2]29.65	WSW	NW, 7	NW	WNW, 9	WNW-NW.
Caledonia, Br. S. S.	Glasgow	Halifax	44 56 N.	45 03 W.	21	3p, 21	22	29.15	SSE	WSW, 9	W	SSE, 9	SSE-WSW.
Quaker City, Am. S. S.	Dundee	Boston	45 37 N.	40 51 W.	21	6p, 21	22	29.27	S	S, 10	SW	SW, 10	S-WSW.
Boschdyk, Du. S. S.	Rotterdam	do	44 21 N.	40 08 W.	23	5a, 23	23	[2]29.14	S	SSE, 9	S	SSE, 9	SSE-WSW.
Waukegan, Am. S. S.	Havre	New York	37 13 N.	63 22 W.	23	2a, 24	24	29.61	SSW	SSW, 10	WNW	SSW, 10	SSW-SW.
Scoharie, Am. S. S.	Bremen	Savannah	44 10 N.	30 00 W.	22	4a, 24	24	29.64	SSW	S, 9	SW	S, 9	S-SW.
Campoamor, Span. M. S.	Bilboa	Philadelphia	38 40 N.	58 20 W.	24	3p, 24	25	[2]29.41	S	S, 3	W	SW, 10	S-SW-W.
Scanstates, Am. S. S.	Copenhagen	New York	43 00 N.	57 00 W.	24	Mdt, 24	25	28.78	W	W, 9	W	W, 9	S-W-WNW.
Paris, Fr. S. S.	Havre	do	41 30 N.	50 42 W.	25	3a, 25	25	29.35	SW	WSW, 8	WNW	W, 11	S-WSW-W.
Cheyenne, Br. M. S.	Belfast	Baytown, Tex.	32 15 N.	58 58 W.	26	10p, 26	27	29.50	SW	SW, 9	NW	SW, 10	SW-NW.
Yorkmoor, Br. S. S.	St. Vincent, Cape Verde Is.	Halifax	35 45 N.	51 40 W.	26	4a, 27	27	29.43	SW	SW, 8	W	WSW, 9	SW-WNW.
Pres. Harding, Am. S. S.	Cobh	New York	42 40 N.	44 35 W.	27	9a, 27	27	29.02	SW	S, 9	W	SW, 10	SW-S-SW.
Schoharie, Am. S. S.	Bremen	Savannah	38 40 N.	48 00 W.	26	3p, 27	27	29.54	SW	SW, 10	W	SW, 10	SW-N.
Pres. Harding, Am. S. S.	Cobh	New York	41 02 N.	63 40 W.	29	3p, 29	29	29.61	S	S, 8	NW	S, 9	S-WNW.
NORTH PACIFIC OCEAN													
Nordbo, Dan. M. S.	Osaka	Vancouver, B. C.	40 20 N.	163 40 E.	[1]28	4a, 1	1	29.51	SE	S, 8	SSW	SSE, 9	SSE-S-SSW.
Makawao, Am. S. S.	Port Allen, T.H	San Francisco	34 31 N.	133 39 W.	28	do	1	29.74	WNW	NNW, 8	N	N, 9	NNW-N.
Atheichief, Br. M. S.	Yokohama	Los Angeles	43 15 N.	170 00 E.	1	3p, 1	1	29.39	SSE	SE, 9	S	SE, 9	SE-S.
General Sherman, Am. S. S.	Portland, Oreg.	Yokohama	47 42 N.	162 48 E.	1	6a, 2	2	28.96	SE	E, 3	WNW	SE, 9	SSE-E-NW.
Olympia, Am. S. S.	Yokohama	Vancouver, B. C.	49 18 N.	135 10 W.	1	6p, 3	3	29.46	W	N, 8	N	WNW, 10	W-N-NNE.
Makura, Br. S. S.	Papeete	San Francisco	8 35 N.	138 08 W.	3	4a, 4	4	29.66	E	ENE, 7	ENE	E, 9	E-ENE.
Aorangi, Br. M. S.	Victoria	Honolulu	25 30 N.	154 00 W.	4	6p, 4	4	29.87	S	S, 8	S	S, 9	SE-S.
Tamaha, Br. S. S.	Yokohama	Los Angeles	41 38 N.	168 45 E.	5	Noon, 5	5	29.09	ESE	SW, 7	SSW	ESE, 9	ESE-SW.
Pres. Hoover, Am. S. S.	Honolulu	Yokohama	34 24 N.	154 48 E.	7	10a, 6	7	29.43	NW	SW, 7	NW	NW, 9	SW-WNW.
Golden Horn, Am. S. S.	Dairen	San Francisco	[3]39 57 N.	150 32 E.	6	Mdt, 6	6	28.97	WNW	SW, 8	SW	SW, 9	WNW-SW.
Empress of Japan, Br. S. S.	Honolulu	Yokohama	29 38 N.	156 47 E.	7	8a, 7	7	29.66	W	W, 8	NW	WNW, 9	
Golden Dragon, Am. S. S.	Manila	San Francisco	38 27 N.	179 50 E.	7	1p, 7	7	29.45	S	S, 9	S	S, 9	None.
Hikawa Maru, Jap. M. S.	Vancouver, B. C.	Yokohama	51 04 N.	173 30 W.	7	10p, 7	8	28.38	SSW	SSW, 8	W	W, 9	SSE-SSW-S.
San Pedro Maru, Jap. M. S.	Yokohama	Los Angeles	[3]37 36 N.	163 54 E.	9	3a, 8	9	29.41	WSW	SW, 4	WNW	W, 9	SW-WSW.
Talthybius, Br. S. S.	do	Vancouver, B. C.	49 54 N.	139 12 W.	11	3p, 9	11	29.44	SE	S, 7	SE	SE, 9	S-W.
Golden Star, Am. S. S.	San Francisco	Yokohama	34 37 N.	141 50 E.	9	2p, 10	10	29.69	SW	W, 9	W	SW, 10	SW-W.
Grays Harbor, Am. S. S.	Tacoma	do	35 00 N.	153 06 E.	10	1a, 11	11	29.72	SSW	SSW, 9	W	SSW, 9	SSW-W.
Hikawa Maru, Jap. M. S.	Vancouver, B. C.	do	48 08 N.	164 08 E.	11	2p, 11	13	28.75	SW	S, 5	NW	WNW, 11	ESE-S-SW.
Oregon, Am. S. S.	Dairen	San Francisco	41 51 N.	155 00 E.	10	do	13	29.31	SSW	WNW, 9	WNW	WNW, 11	None.
Tercero, Nor. M. S.	do	Los Angeles	41 45 N.	176 00 W.	11	6p, 12	12	29.17	SW	SSW, 10	W	SSW, 10	SSW-W.
City of Vancouver, Br. S. S.	Muroran, Japan	Vancouver, B. C.	44 26 N.	151 41 E.	11	10a, 11	13	28.78	NW	W, 4	WNW	WNW, 10	SW-NW.
Hakonesan Maru, Jap. M. S.	Yokohama	Los Angeles	46 36 N.	173 00 W.	13	1a, 14	13	29.00	WSW	WSW, 7	S	S, 9	None.
Grays Harbor, Am. S. S.	Tacoma	Yokohama	34 55 N.	146 45 E.	13	1p, 13	13	29.70	WSW	W, 8	W	WSW, 10	WSW-NNW.
Pres. Jackson, Am. S. S.	Yokohama	Victoria, B.C.	48 00 N.	172 25 E.	11	10p, 13	13	28.83	W	SW, 6	SW	WNW, 10	SW-N.
Golden Horn, Am. S. S.	Dairen	San Francisco	47 30 N.	178 54 W.	13	Mdt, 13	14	29.14	WSW	WNW, 7	SW	WSW, 9	WSW-WNW.
Somerville, Nor. M. S.	Hong Kong	Los Angeles	41 49 N.	165 00 E.	13	6a, 14	14	29.10	SSW	SSW, 9	W	S, 10	S-SSW-W.
Atlantic City, Br. S. S.	San Diego	Balboa	[3]14 51 N.	94 33 W.	14	4p, 14	14	30.06	NE	N, 6	NNW	N, 8	N-NNW.
Hanover, Am. S. S.	Honolulu	Los Angeles	26 12 N.	146 05 W.	14	do	14	29.66	NNW	NNW, 9	NNE	NW, 10	NW-N.
Nojima Maru, Jap. M. S.	Yokohama	do	45 47 N.	179 26 E.	12	Mdt, 14	14	29.19	NW	SE, 6	W	NW, 10	S-SE-E.
Makua, Am. S. S.	Seattle	Kaanapali	28 54 N.	149 48 W.	14	5a, 15	15	30.01	NNE	NE, 9	NNE	NE, 9	N-NE-NNE.
Comeric, Br. S. S.	Miike	New Westminster.	40 27 N.	139 00 E.	17	Mdt, 16	17	29.73	NW	WNW, 7	W	NW, 8	
Atlantic City, Br. S. S.	San Diego	Balboa	9 27 N.	86 25 W.	16	6a, 17	19	29.93	NE	N, 2	N	NE, 7	
Empress of Asia, Br. S. S.	Vancouver, B. C.	Yokohama	46 08 N.	158 54 E.	17	2a, 18	18	28.60	S	WNW, 10	NW	NW, 11	SW-WNW-NW.
Pennsylvania, Am. S. S.	Otaru, Japan	San Francisco	47 40 N.	164 00 E.	17	7a, 18	18	28.71	S	WSW, 9	W	S, 10	SSW-W.
Pres. Jefferson, Am. S. S.	Victoria, B. C.	Yokohama	50 24 N.	131 22 W.	19	2p, 19	20	29.51	WNW	WNW, 8	NNW	NNW, 9	None.

[1] February. [2] Position approximate. [3] Barometer uncorrected.

OCEAN GALES AND STORMS, MARCH 1935—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began March —	Time of lowest barometer March —	Gale ended March —	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH PACIFIC OCEAN—Continued			° ′	° ′				*Inches*					
Niagara, Br. S. S.	Honolulu	Victoria, B. C.	43 09 N.	134 19 W.	18	3p, 20	20	30.03	E.	NNW, 7	NNW	NW, 10	
Tyndareus, Br. S. S.	Yokohama	do	41 18 N.	152 14 E.	22	2a, 23	23	29.33	N.	NNW, 10.	NW.	NNW, 10.	NNE-NW.
Jefferson Myers, Am. S. S.	do	Los Angeles	41 42 N.	159 56 E.	22	8a, 23	23	29.30	E.	SSE, 8	W.	SW, 10	SSE-SW.
Comeric, Br. S. S.	Miike	New Westminster.	49 16 N.	167 22 E.	23	8p, 23	24	29.42	SE.	SSW, 9	WSW.	SW, 9	SE-S-SW.
Oregon, Am. S. S.	Dairen	San Francisco	43 06 N.	135 48 W.	23	3a, 24		29.80	WSW.	WSW, 8		WSW, 9	WSW-W.
Nitro, U. S. N. Aux.	Pearl Harbor	Bremerton	[1]48 14 N.	125 40 W.	24	11p, 24	24	29.30	WNW.	SW, 6	W.	WNW, 9	
San Diego Maru, Jap. M. S.	Kobe	San Francisco	35 07 N.	148 00 E.	25	4p, 25	25	[2]28.92	SE.	SW, 8	WSW.	ESE, 9	ESE-SW-WSW.
Nichiyo Maru, Jap. M. S.	Yokohama	do	38 40 N.	147 20 E.	25	9a, 26	27	28.85	SE.	SSW, 9	WSW.	ESE, 9	SSW-SW.
Pres. Jefferson, Am. S. S.	Victoria, B. C.	Yokohama	45 54 N.	159 02 E.	26	Mdt, 27	27	29.04	ESE.	E, 3	E.	E, 9	E-NNE.
Steel Traveler, Am. S. S.	Los Angeles	Honolulu	27 28 N.	143 10 W.	28	4a, 28	28	29.85	WSW.	SSE, 7	WSW.	WSW, 9	SSE-WSW.
Meigs, U. S. A. Trans.	Manila	San Francisco	37 06 N.	138 00 W.	29	3a, 30	30	29.79	ESE.	ESE, 8	ESE.	ESE, 8	None.
SOUTH PACIFIC OCEAN													
Eclipse, Br. S. S.	Dunedin, N. Z.	Los Angeles	27 30 S.	169 15 W.	21	Mdt, 21	22	29.53	ESE.	E, 8	SSE.	ESE, 9	E-SSE.
Maunganui, Br. S. S.	Wellington	Rarotonga	26 57 S.	165 36 W.	22	8a, 22	22	28.90	ESE.	SSE, 12	SSW.	SSE, 12	ESE-SSE.

[1] Position approximate.

[2] Barometer uncorrected.

NORTH PACIFIC OCEAN, MARCH 1935

By WILLIS E. HURD

Atmospheric pressure.—The average atmospheric pressure over the North Pacific Ocean for March 1935 shows the center of the Aleutian LOW to have been over the Bering Sea, at a somewhat higher latitude than usual for the month. The pressure at the approximate center (29.74 at St. Paul Island) was close to normal. Along the Alaskan Peninsula and the Aleutians pressure was approximately 0.20 inch above the normal. This was due to two facts, viz, the unusual northward movement of many of the high-latitude centers of cyclonic action, and the passage of extensive high-pressure areas along the neighborhood of the forty-fifth to fifty-fifth parallels. The lowest recorded pressure of the month was 28.38 inches, observed at St. Paul on the 14th, and on the 7th near 51° N., 173° W., as reported by the Japanese M. S. *Hikawa Maru.* In the Aleutians the highest pressure was 30.68 inches at Dutch Harbor on the 18th.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, March 1935, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	30.25	+0.10	30.94	26	29.72	10, 17
Dutch Harbor	29.88	+.18	30.68	18	28.78	8
St. Paul	29.74	+.01	30.50	18	28.38	14
Kodiak	29.92	+.23	30.46	19	29.08	9
Juneau	29.89	−.05	30.47	29	28.96	23
Tatoosh Island	29.92	−.04	30.37	15	29.20	24
San Francisco	30.06	.00	30.39	11	29.67	6
Mazatlan	29.92	.00	30.00	14	29.84	26, 27
Honolulu	29.98	−.06	30.14	13	29.79	18
Midway Island	30.07	.00	30.26	17	29.82	9
Guam	29.85	−.05	29.94	14, 16	29.76	4
Manila	29.87	+.01	29.94	6, 9	29.80	2, 3
Hong Kong	29.94		30.08	6	29.70	27
Naha	30.01	+.01	30.16	5, 6	29.68	27
Chichishima	30.00	.00	30.24	15	29.84	2, 3, 28, 31
Nemuro	29.85		30.46	23	29.18	25

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

A secondary LOW in the average pressure situation over the northeastern part of the Pacific reflected the frequent cyclonic action of the month to southeastward of the Alaskan Peninsula.

In middle latitudes pressure was practically normal and moderately high along the entire width of the ocean.

In lower latitudes pressure was normal or nearly so at the extreme eastern and western stations, as typified by Manila and Mazatlan, but was below normal at Guam and Honolulu.

Cyclones and gales.—March 1935 cannot be characterized as an intensely stormy month on the North Pacific, yet gales were frequent along the western part of the northern steamship routes, particularly between the central Aleutians and the Japanese islands of Honshu and Hokushu. In some localities east of the Kurile Islands winds of force 8 to 10 occurred about 1 day in 4. Gales of force 11 have been reported on 4 dates only—the 11th, 12th, 18th, and 28th.

Over northern mid-ocean, gales were less intense and much less frequent than to the westward, and from higher latitudes between 150° and 160° W. no winds of gale force have been reported. East of 150° W. there were two regions of some storminess: One north of the fortieth parallel, between 140° W. and the American coast; the other about midway between the easternmost Hawaiian Islands and the California coast.

The Tropics were generally quiet, except for a few isolated gales.

Three extra-tropical cyclones of some importance originated in the Far East. The first crossed northern Japan on the 4th and entered the Bering Sea by way of the central Aleutians on the 8th. This storm spread greatly in area after passing to sea and was productive of fresh to strong gales over a considerable extent of ocean. On the 7th, 8th, and 9th, while the cyclone was central over extreme northern waters, the gale field gave scattered high wind velocities from the Aleutians southward and southwestward as far as the thirty-fifth to thirtieth parallels. The lowest pressure of the month reported on shipboard, 28.38 inches, occurred in connection with this storm late on the 7th, just south of Atka Island, in the central Aleutians.

The second cyclone of note appeared central over Hokushu and the southern Kuriles on the 9th and 10th. Gales of force 10 occurred in connection with it as far

south as southeastern Honshu on the 10th. On the 11th and 12th the storm increased in energy as it proceeded northeastward, the wind rising to force 11 on the earlier date near 42° N., 155° E., and on the 12th near 48° N., 164° E. On the 13th and 14th the disturbance was central over the Bering Sea, but accompanying winds of fresh to whole gale force were experienced by a number of ships between 40° and 50° N., 160° E. and 160° W.

The third cyclone formed as a depression south of Japan about the 24th. Its center moved north along the Japanese east coast until the 27th, when it lay east of the Kuril Islands. Thence it proceeded into the Bering Sea. Gales of force 8–9 accompanied it during most of its passage of the usual ship-traveled zone during the 25th–26th. On the 27th, however, the Japanese S. S. *Hiye Maru* experienced gales of force 10 near 45° N., 155° E., with barometer depressed to 28.67 inches. On the early morning of the 28th, while the storm center was far to the northeastward, this ship experienced a west gale of force 11 near 42° N., 149° E.

On the 18th the British S. S. *Empress of Asia* encountered a gale of force 11, barometer 28.60, near 46° N., 159° E. It is evident that a deep cyclone was then in existence in this stormy northwestern sector of the ocean, but little is known of its history, except that on the 18th winds of force 10, in addition to the force 11 mentioned, occurred over a considerable region east of the Kuril Islands.

On the 11th, 12th, and 24th ships encountered fresh to strong gales off the Washington and Oregon coasts, and to seaward practically as far as 140° W. The highest wind velocity at the exposed land station, Tatoosh Island, was 56 miles from the southwest on the 24th. The 2d, 3d, and 20th were also stormy days locally between approximately 40° and 50° N., 130° and 145° W., with gales of force 10 occurring on the 2d and 20th.

Northeast of the Hawaiian Islands several depressions affected the weather situation. The first was of brief existence, but resulted in a gale of force 9 near 25° N., 154° W. The most important LOW was that which appeared central near 27°–28° N., 142°–143° W., on the 14th and 15th, thence moved slowly northwestward, diminishing in intensity until its disappearance on the 22d north of Midway Island. During the 14th and 15th —the only days on which gales were reported in connection with the disturbance—the field of high winds lay roughly between 25° and 35° N., 135° and 150° W. The maximum wind force was 10, near 26° N., 146° W., on the 14th.

On March 4 the British S. S. *Makura* reported an east gale of force 9 in 8° 35′ N., 138° 08′ W. Owing to the fact that the ship's corrected barometer fell to 29.66 on that date, there is room for a reasonable suspicion that a depression had formed in the vicinity.

Tehuantepecers.—Northers occurred in the Gulf of Tehuantepec as follows: Of force 7 on the 2d; of force 8 on the 14th.

Fog.—The distribution of fog differed considerably in March from that of the preceding February, there being a much less occurrence along the American coast, except in the Tropics, and much more trans-Pacific fog. For the coast, it was reported on 2 days north of the 30th parallel; on 1 day off Lower California; on 5 days in the Gulf of Tehuantepec; and on 1 day near the Costa Rica coast. Along the eastern two-thirds of the northern and central routes 1 to 4 days of fog were observed in most of the 5° squares north of 35° N.

SEA-SURFACE TEMPERATURE SUMMARY FOR THE WESTERN CARIBBEAN SEA

By GILES SLOCUM

The area embraced in this summary is the 5° square from 80° W. to 85° W. and 15° N. to 20° N. The table shows monthly mean sea-surface temperatures, computed to tenths of a degree for the period 1920 to 1933, inclusive.

Monthly and annual sea-surface temperatures in the western Caribbean Sea, 1920 to 1933, inclusive

Year	Total number of observations for the year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1920	205	77.7	78.0	78.8	79.4	80.5	81.1	81.3	82.0	82.2	81.8	82.2	80.2	80.4
1921	328	78.5	79.4	78.4	79.8	80.7	80.9	81.8	81.7	81.9	81.8	80.7	80.4	80.5
1922	246	79.5	78.6	79.3	79.2	79.8	81.2	81.6	81.8	83.0	82.2	81.6	79.2	80.6
1923	366	78.4	78.0	78.5	79.5	81.1	80.9	81.7	82.4	82.7	81.4	80.8	79.5	80.4
1924	331	78.7	77.7	78.4	79.7	81.3	81.8	81.5	82.8	84.2	82.0	81.0	79.8	80.7
1925	512	78.9	78.9	78.6	80.6	81.4	81.4	81.4	82.3	82.5	82.7	82.1	80.9	81.0
1926	602	79.6	78.9	79.5	81.1	82.2	82.3	83.2	83.1	82.1	82.8	81.6	80.9	81.4
1927	624	79.0	79.3	79.6	80.2	81.3	82.4	82.3	83.1	84.2	83.6	81.7	80.5	81.4
1928	608	78.8	78.5	78.6	79.5	80.8	81.5	81.3	82.9	82.8	82.6	81.9	79.4	80.7
1929	714	79.4	78.8	79.7	80.0	80.2	81.5	82.0	82.3	82.5	82.4	81.9	80.0	80.9
1930	616	78.6	78.9	79.5	79.9	82.2	82.1	82.3	83.0	83.4	83.7	81.9	80.5	81.3
1931	679	80.5	79.2	79.8	80.6	83.2	83.9	83.6	83.7	83.9	83.2	81.8	80.7	82.0
1932	665	80.1	79.6	80.1	80.5	80.8	82.5	82.8	83.6	84.4	84.1	81.1	79.6	81.6
1933	690	79.3	79.5	79.9	80.4	81.4	82.8	83.0	83.6	83.4	82.5	81.3	79.4	81.4
Number of years' record	------	14	14	14	14	14	14	14	14	14	14	14	14	14
Mean (1912–33)	------	79.1	78.8	79.2	80.0	81.2	81.9	82.1	82.7	83.1	82.8	81.5	80.1	81.0

DUST STORMS

[Compiled by W. A. MATTICE]

Dust storms, or wide-spread dusty conditions, were first brought to the attention of many people during November 1933 when dust was transported from our Midwestern States to eastern sections. During the spring of 1934 other wide-spread distributions of dust occurred, culminating with one of marked intensity in May. These storms have been rather fully reported in the February 1935 MONTHLY WEATHER REVIEW.

The period June 1, 1934, to February 28, 1935, was one of continued dusty conditions over the Plains States. There were not, however, such favorable combinations of air movement as to carry the dust over great distances. The storms were confined largely to the section of origin—the western Plains. Figure 1 shows for this period the number of days with dusty conditions, as reported by first-order stations of the Weather Bureau. There are two regions of intense dustiness, centered in eastern South Dakota and in northwestern Texas. The latter locality has continued to be unfavorably dry, but the former had beneficial precipitation during early April this year. During the period under consideration there were only two instances of dust being transported over large distances from the place of origin. The first was around June 1, 1934, and the second about February 22, 1935. In neither of these cases, however, was the dust widely distributed; it was confined to the upper Mississippi Valley, except for scattered, localized occurrences elsewhere.

During March 1935 dust storms increased in frequency, if not in intensity. Figure 2 shows the number of days with dusty conditions reported during March. The region of greatest dustiness was again the Texas Panhandle and southwestern Kansas where there has been no relief from the extremely dry conditions that have persisted so long.

The following extracts from reports of section centers show the intensity and seriousness of the dust:

Denver, Colo.—February 1935. Frequent destructive duststorms which occurred from the foothills region to the Kansas border became so severe at times that schools were closed and people generally remained indoors. It was sometimes necessary to use artificial light during the midafternoon. One death resulted on the 21st near Arriba when two section cars collided on a railroad, due to limited visibility during the storm.

March 1935: Loose topsoil from thousands of farms in the drought-stricken area of eastern Colorado was carried by winds of high velocity, reducing visibility and causing hazardous driving and flying conditions. The wind velocity at the Denver Municipal Airport reached 77 miles per hour during the afternoon of the 15th. The total loss at Canon City as a result of the storm was estimated at $8,000. Telephone lines were blown down, houses seriously damaged, windows crushed, and highway travel made extremely dangerous through Fremont County, where the total damage was estimated at $20,000. Cherry orchards in the rich agricultural section between Fort Collins and Loveland suffered severely when

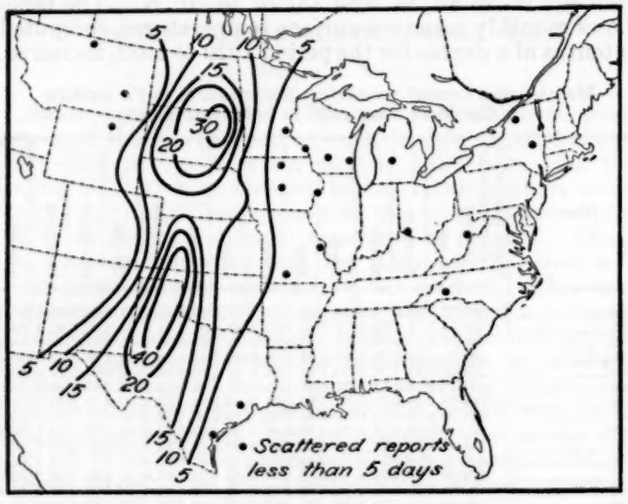


FIGURE 1.

the freshly plowed soil was swept away, leaving the roots of the trees bare. The topsoil was also blown from many fields that produce winter wheat and alfalfa. The damage was greatest in southeastern counties, e. g., Kiowa, Prowers, Baca, and eastern Bent and Las Animas Counties, where the suffocating dust storms which occurred frequently from the 12th to the 25th brought death to 6 persons and serious illness to more than 100 others. In many places the dust lay from a few inches to more than 6 feet deep and considerable livestock perished from starvation and suffocation.

Numerous reports state that since the storm on the 15th the air has been more or less dust-laden, making breathing and living conditions generally uncomfortable. Schools were closed in many localities as a measure of safety and many ranch homes were deserted by their tenants. Reliable reports state that no accurate estimate of the damage to topsoil through the drought area can be made, but that it will amount to millions of dollars.

Huron, S. Dak.—The storm of March 28 was the worst of the season. This dust storm, accompanied by a high wind, dried out the top surface of the soil rapidly. The encouraging feature of the storm was the many reports to the effect that most of the blowing soil was not local, but from other States. There was some damage to growing crops which by the last day of the storm were wilting and being pounded into the ground.

Albuquerque, N. Mex.—The most severe and wide-spread storm occurred on March 27–28. On the 27th dust hung over the eastern tier of counties, slowly thickening and spreading westward. Visibility was from one-fifth to 3 miles. On the 28th it had extended westward to the one hundred and seventh meridian in northern and central sections and nearly to the western border south of the thirty-third parallel. During this period the sun was completely obscured much of the time. Visibility was zero in eastern counties and from one-fifth to three-fourths mile in central areas. Dust and sand storms were both frequent and severe on other dates. Much damage resulted, some of permanent nature, from blowing soil in the eastern plains section. Severe storms were noted on the 4th-5th, 15th to 20th, and 27th to 30th.

Houston, Tex.—Duststorms were unusually widespread and severe during March 1935, there being only three dates on which dust was not reported at some station in the State, namely the 2d, 12th, and 24th. During the first half of the month, dust was reported at many northwestern and western stations and at a few stations in the central portion of the State. The most severe storm during this period occurred on the 3d and 4th; many towns in the northwestern division reported that lights were necessary during the daytime, especially on automobiles, and at intervals the darkness was equal to that of the darkest night.

From an agricultural standpoint the Panhandle section seems to have suffered the only ill effects of the duststorms; vegetation was retarded in general, even where sufficient subsoil moisture existed, while soil erosion, due to accompanying strong winds, was great.

Des Moines, Iowa.—The most extensive reports were on March 20, with very widespread duststorms. Dust very dense for short periods of time. In extreme southwest corner of State, visibility of only 100 feet reported at Riverton, 300 feet at Thurman, and 200 yards at Shenandoah.

An encouraging feature of these storms is the fact that the major soil blowing seems to have been confined to a

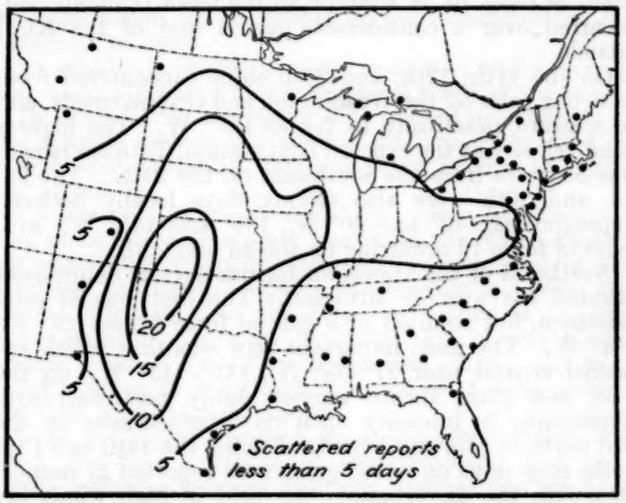


FIGURE 2.

relatively small portion of the agricultural area of the country. The section of greatest intensity is localized in the Panhandle of Texas and adjoining parts of other States, comprising only a small part of the total crop lands. The damage from these storms, although severe in certain localities, is not great, considering the whole agricultural sections of the United States. The principal cause of much crop loss in sections adjoining the area of greatest soil blowing was the extreme drought that has prevailed there for a long time. In fact, it has been reliably indicated that much of the wheat in this portion was already severely injured by dryness, if not actually killed.

So far this year, to mid-April, there has not been any great movement of soil outside the critical area mentioned above. The northern Plains have had beneficial precipitation in many parts and, while some increasing dryness is apparent, rains or snows have been adequate to prevent any large movement elsewhere in the Plains.

During the period June 1, 1934, to February 28, 1935, there were 513 reports of dust or dusty conditions, averaging about 57 reports a month, although not equally

distributed. The reports were rather numerous from western sections during June-October 1934, but then decreased in number until the latter part of February 1935. During March 1935, as last reported, there were 615 instances of duststorms or dusty conditions, many of them being light and not appreciably affecting the visibility, particularly in Eastern States. West of the Appalachian Mountains to the Rockies, however, there were many instances of visibilities less than 1 mile, a total of 138 such occurrences being noted. The total number of first-order Weather Bureau stations reporting the presence of dusty conditions was 119, or a large majority of those canvassed. The great duststorm of last May, previously noted, brought only 182 reports from Weather Bureau stations. As this was considered the worst one at that time, it is evident that March 1935 probably breaks all previous records as a dusty month, but the records for previous years have not been examined.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, March 1935

[For description of tables and charts, see REVIEW, January, p. 37]

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	62.1	+6.3	Eufaula	90	23	Goodwater	19	1	7.30	+1.37	Seven Hills	16.12	Geneva	2.62
Arizona	49.9	−4.2	Gila Bend	92	30	Bright Angel R. S.	−7	6	1.50	+.54	Bright Angel R. S.	6.16	Wellton	.04
Arkansas	58.7	+6.2	2 stations	90	[1] 25	Sunset	18	7	8.29	+3.50	Lutherville	16.35	Magnolia	1.85
California	46.1	−5.3	do	96	[1] 14	2 stations	−18	9	3.88	+.29	Inskip	12.73	2 stations	T
Colorado	37.4	+2.9	Holly	87	15	Hermit (near)	−35	6	1.00	−.30	Cumbres	6.89	9 stations	T
Florida	69.3	+3.8	4 stations	96	[1] 22	Cottage Hill	21	1	.99	−2.11	Caryville	3.85	3 stations	.00
Georgia	61.4	+5.0	2 stations	95	22	Blairsville	10	1	4.59	−.29	Flat Top	8.74	Fargo	.83
Idaho	33.5	−2.3	Grand View	78	15	Pelton Ranch	−17	5	1.72	−.02	Pierce	7.02	Aberdeen	.30
Illinois	47.0	+7.0	New Burnside	85	23	Mount Carroll	4	8	4.64	+1.57	Cairo	12.00	Oregon	1.56
Indiana	48.0	+7.4	Shoals	85	[1] 20	Notre Dame	14	9	5.05	+1.29	Madison	10.21	Greencastle	2.14
Iowa	40.7	+6.3	Sioux City	85	15	6 stations	−2	[1] 7	1.47	−.26	Keosauqua	6.82	Clarinda	.24
Kansas	51.0	+7.8	2 stations	90	15	Hanover	0	7	.82	−.62	Coffeyville	3.88	2 stations	T
Kentucky	54.6	+8.4	Princeton	86	22	Quicksands	20	1	9.56	+4.85	Princeton	14.65	Grant	4.93
Louisiana	66.1	+5.6	Dodson	94	22	Franklinton	21	1	6.43	+1.64	Angola	15.86	Grand Cane	1.14
Maryland-Delaware	47.6	+4.6	Hancock, Md	86	16	Sines, Md	10	9	3.02	−.42	Friendsville, Md	4.51	Picardy, Md	1.95
Michigan	33.8	+4.2	St. Joseph	75	16	Sidnaw	−16	3	1.93	−.24	St. Joseph	4.52	St. Ignace	.32
Minnesota	29.3	+3.0	Pipestone	73	14	2 stations	−18	12	1.52	+.33	Pigeon River Bridge	3.00	Angus	.48
Mississippi	63.2	+6.4	3 stations	90	[1] 27	do	23	1	8.33	+2.51	Woodville	17.30	Pontotoc	2.39
Missouri	50.4	+6.7	Jackson	87	23	Maryville	8	[1] 7	5.27	+2.09	Sikeston	14.61	Edgerton	.29
Montana	28.8	−1.9	Whitehall	79	14	Medicine Lake	−34	7	1.28	+.32	Haugan	7.19	Simpson (near)	.11
Nebraska	42.7	+6.5	2 stations	89	[1] 15	Ewing	−8	7	.78	−.32	Fort Robinson	2.80	Upland	.05
Nevada	38.5	−1.9	Logandale	89	30	Mariette Lake	−5	9	.85	−.13	Mariette Lake	3.86	2 stations	.00
New England	33.5	+1.3	Waterbury, Conn	76	16	Bloomfield, Vt	−22	1	1.82	−1.46	Lake Konomoc, Conn.	3.29	Brattleboro, Vt	.82
New Jersey	43.0	+3.9	2 stations	81	16	Runyon	−6	1	2.46	−1.32	Pillipsburg	3.51	Belleplain	1.51
New Mexico	45.2	+1.4	Nara Visa	90	27	2 stations	−10	[1] 6	.39	−.36	Chama	2.45	21 stations	.00
New York	35.1	+3.0	Geneva	76	16	do	−24	[1] 1	2.05	−.97	Booneville	3.34	Beaver River	.75
North Carolina	55.5	+5.6	3 stations	91	21	Mount Mitchell	10	1	5.01	+.78	Banners Elk	9.16	Southport	.74
North Dakota	26.3	+2.2	Mott	75	14	Dunn Center	−37	7	1.02	+.32	Richardton	2.49	Howard	.20
Ohio	46.2	+7.5	2 stations	80	[1] 16	Hiram	14	9	3.35	−.02	Hillsboro	7.16	Lake Milton	1.35
Oklahoma	57.4	+6.8	Hugo	94	26	5 stations	17	7	3.86	+1.66	Spavinaw	11.61	Boise City	.30
Oregon	37.3	−3.6	Brookings	78	28	2 stations	−7	9	2.98	+.22	Jensen Ranch	14.27	Prineville	.05
Pennsylvania	42.8	+5.1	2 stations	83	16	Gouldsboro	−6	9	2.62	−.82	Greensburg	4.49	Gratersford	1.22
South Carolina	59.7	+5.1	do	94	21	Chester	18	1	2.62	−1.28	Caesars Head	5.30	Charleston	1.02
South Dakota	36.2	+5.3	5 stations	82	[1] 14	Lemmon	−16	6	1.27	+.15	Leola	3.10	Bison	.25
Tennessee	56.7	+7.4	Etowah	89	23	Norris	11	1	7.77	+2.36	Erwin	13.18	Gatlinburg	4.46
Texas	64.0	+5.3	Mission	103	27	4 stations	20	[1] 1	1.82	−.26	Bon Wier	8.25	7 stations	.00
Utah	36.8	−1.6	St. George	81	29	Soldier Summit	−15	6	1.41	+.02	Silver Lake	5.01	Wendover	.10
Virginia	50.6	+4.9	Clarksville	87	22	Pennington Gap	11	1	4.95	+1.23	Emory	10.25	Mount Weather	1.41
Washington	38.3	−2.7	Hanford	78	13	Winthrop	−4	5	4.29	+1.00	Wynoochee Oxbow	23.40	3 stations	.02
West Virginia	48.7	+6.3	2 stations	86	[1] 16	Gary	10	1	5.51	+1.59	Williamson	11.87	Wardensville	1.65
Wisconsin	32.1	+2.8	Beloit	71	15	Long Lake	−14	3	1.32	−.45	Cornucopia	3.39	Plum Island	.34
Wyoming	30.4	+.9	Torrington	78	14	South Pass City	−27	10	.97	−.20	Bechler River	5.15	Moorcroft	.14
Alaska (February)	15.5	+5.5	Sitka	57	3	Allakaket	−59	1	2.73	+.68	Cordova	18.22	Barrow	.01
Hawaii	69.4	+.5	Waimanalo	89	9	Kanalohuluhulu	42	22	7.40	−1.67	Kapoho	23.52	Mahukona	.70
Puerto Rico	72.4	−1.0	Bayamon	91	28	Guineo Reservoir	45	[1] 18	1.67	−1.81	2 stations	7.56	7 stations	.00

[1] Other dates also.

TABLE I.—*Climatological data for Weather Bureau stations, March 1935*

[Compiled by Annie E. Small, by official authority, U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							35.5	+2.8										69	1.80	−1.7										5.4		
Eastport	76	67	85	29.87	29.95	+0.02	29.2	+0.3	48	11	36	5	1	23	24	26	21	73	1.48	−2.4	11	8,531	nw.	30	nw.	18	10	8	13	5.6	11.5	3.2
Greenville, Maine	1,070	6	40	28.77	29.98	.....	24.0	.....	57	17	34	−13	15	14	40	.....	.....	.....	1.79	.....	11	6,481	nw.	34	.....	17	11	8	12	.....	15.5	.....
Portland, Maine	103	82	117	29.89	30.01	+.05	33.4	+1.6	56	11	41	10	1	26	27	29	23	67	1.96	−1.9	15	6,889	n.	35	nw.	3	18	8	5	3.6	4.8	.0
Concord	289	60	.....	.....	.....	.....	34.4	+3.6	67	16	45	−6	1	24	.....	.....	.....	.....	1.29	−1.7	9	.....	nw.	.....	.....	.....	13	8	10	.....	4.3	.....
Burlington	403	11	48	29.58	30.04	+.04	29.6	+.5	58	17	38	−1	1	21	40	.....	.....	.....	.88	−1.2	14	8,706	s.	43	s.	23	8	10	13	5.8	2.5	.0
Northfield	876	12	60	29.06	30.04	+.04	29.2	+2.8	63	16	40	−8	1	18	42	25	20	71	1.09	−1.5	13	6,608	n.	32	sw.	17	6	14	11	6.0	2.9	T
Boston	124	336	360	29.89	30.03	+.06	38.4	+2.8	71	16	47	16	1	30	36	33	23	58	1.52	−2.0	11	11,679	w.	49	nw.	22	8	15	8	5.2	2.1	.0
Nantucket	12	14	90	30.02	30.03	+.05	37.8	+2.3	54	20	43	24	1	32	18	35	31	76	2.71	−1.0	8	11,582	sw.	39	sw.	17	10	9	12	5.5	T	.0
Block Island	26	11	46	30.01	30.04	+.06	38.7	+3.3	56	22	44	22	9	33	20	36	32	78	2.44	−1.4	11	12,376	sw.	46	nw.	17	9	9	13	5.9	1.5	.0
Providence	160	215	251	29.86	30.04	+.06	40.4	+4.7	72	16	49	17	1	32	37	34	26	60	1.60	−1.9	8	9,477	nw.	43	nw.	17	13	7	11	4.8	.6	.0
Hartford	159	70	104	.....	30.06	+.07	39.4	+4.4	73	16	48	15	1	30	40	.....	.....	.....	1.93	−2.0	9	6,809	s.	.....	.....	.....	11	4	16	.....	4.4	.0
New Haven	106	74	153	29.95	30.07	+.08	40.4	+4.6	70	16	49	17	1	32	34	35	28	66	2.93	−1.2	9	6,787	s.	34	nw.	24	9	6	16	6.0	3.9	.0
Middle Atlantic States							46.2	+5.4										70	2.94	−0.5									6.5		
Albany	97	107	115	29.96	30.06	+.05	36.6	+3.9	68	16	46	10	1	28	37	33	28	74	1.60	−1.0	12	6,293	s.	26	s.	23	8	8	15	6.2	5.5	.0
Binghamton	871	60	68	29.11	30.06	+.04	36.8	+4.2	71	16	47	2	9	27	41	.....	.....	.....	2.37	−.2	16	4,745	nw.	25	w.	17	6	5	20	7.2	10.8	.0
New York	314	415	454	29.72	30.07	+.07	43.2	+5.5	74	16	52	17	9	34	36	37	30	65	2.57	−1.1	9	11,713	nw.	54	nw.	17	10	7	14	5.9	1.0	.0
Bellefonte	1,050	5	42	28.92	30.05	.....	38.7	.....	75	16	50	7	9	28	45	34	30	76	2.05	.....	15	.....	sw.	36	sw.	17	7	8	16	6.8	4.7	.0
Harrisburg	374	94	104	29.65	30.06	+.03	44.4	+5.5	76	16	54	18	9	35	38	38	32	67	2.80	−.2	13	5,507	w.	32	sw.	17	8	11	12	6.1	4.3	.0
Philadelphia	114	168	367	29.91	30.08	+.06	46.2	+5.4	75	16	55	23	9	37	36	39	32	63	2.11	−1.3	13	9,921	sw.	37	sw.	17	10	4	17	6.4	.6	.0
Reading	323	283	306	29.72	30.08	.....	44.6	+4.6	79	16	54	19	9	35	42	39	31	63	2.09	−1.4	12	8,508	nw.	44	sw.	17	9	8	14	6.1	3.2	.0
Scranton	805	72	104	29.18	30.07	+.05	39.5	+3.8	73	16	50	10	9	30	37	34	27	66	2.02	−1.2	13	5,198	sw.	26	sw.	17	6	9	16	6.1	5.8	.0
Atlantic City	52	37	172	30.03	30.09	+.07	44.6	+6.0	73	6	52	23	9	38	27	40	35	74	2.31	−1.3	15	12,640	s.	38	nw.	17	5	9	17	7.2	T	.0
Sandy Hook	22	10	57	30.04	30.06	.....	42.4	.....	70	16	50	22	9	35	32	38	33	73	1.68	−2.4	9	10,628	sw.	44	sw.	17	10	6	15	6.0	1.1	.0
Trenton	190	88	106	29.87	30.08	.....	43.8	+4.7	75	16	53	19	9	34	38	38	32	68	2.17	−1.2	12	6,494	s.	18	s.	16	12	2	17	6.1	1.1	.0
Baltimore	123	100	215	29.95	30.08	+.05	49.4	+7.1	81	16	59	24	9	40	37	42	36	66	2.82	−.9	15	8,185	sw.	32	nw.	17	9	6	16	6.6	1.3	.0
Washington	112	62	85	29.96	30.08	+.04	50.2	+7.6	80	21	60	25	9	40	34	42	35	63	3.39	−.4	16	5,731	s.	25	nw.	17	8	11	12	6.0	.5	.0
Cape Henry	18	8	54	30.07	30.09	.....	53.0	+6.4	84	21	62	29	1	44	36	47	42	74	3.12	−.8	12	9,391	sw.	43	n.	13	6	8	17	7.0	.0	.0
Lynchburg	686	5	.....	29.35	30.10	+.05	52.2	+4.9	85	21	64	20	1	41	36	.....	.....	.....	5.70	+2.2	17	.....	sw.	.....	.....	.....	2	19	10	.....	T	.0
Norfolk	91	80	125	30.01	30.11	+.08	54.3	+6.1	85	21	64	30	1	45	36	48	43	73	4.17	+.4	10	8,245	sw.	32	n.	28	3	8	20	7.7	.0	.0
Richmond	144	11	52	29.95	30.11	+.07	52.2	+5.0	84	21	63	24	1	41	35	46	41	72	4.00	+.3	13	7,312	sw.	31	nw.	17	4	11	16	6.8	T	.0
Wytheville	2,304	49	55	.....	30.08	+.03	48.2	+5.9	73	16	58	22	1	38	38	.....	.....	76	5.08	+1.6	18	5,702	w.	27	w.	7	4	11	16	.....	2.5	.0
South Atlantic States							60.1	+6.4										74	2.70	−1.0									5.8		
Asheville	2,253	89	104	27.74	30.11	+.05	52.4	+7.5	80	21	64	19	1	41	42	45	41	76	3.34	−.6	16	7,168	se.	32	nw.	12	5	8	18	7.2	T	.0
Charlotte	779	63	86	29.26	30.11	+.06	57.0	+6.6	87	21	68	29	1	46	33	50	44	69	5.01	+.8	13	6,411	sw.	24	s.	12	8	7	16	6.4	.0	.0
Greensboro	886	6	56	29.15	30.11	.....	52.5	.....	84	21	64	19	1	41	37	47	43	79	6.52	.....	16	6,722	sw.	36	n.	23	2	12	17	7.3	T	.0
Hatteras	11	5	50	.....	30.12	+.08	57.6	+5.6	73	21	64	31	1	51	21	.....	.....	80	3.49	−.8	10	10,744	sw.	38	nw.	13	11	8	12	.....	.0	.0
Raleigh	376	103	146	29.69	30.10	+.05	56.5	+6.3	86	21	68	28	1	45	32	51	47	76	4.08	+.2	15	7,184	sw.	31	nw.	12	6	12	13	6.4	.0	.0
Wilmington	72	73	107	30.05	30.13	+.08	60.6	+7.3	88	21	70	31	1	51	30	53	50	77	1.88	−1.3	5	8,229	sw.	41	sw.	12	10	11	10	5.0	.0	.0
Charleston	48	11	92	30.08	30.13	+.07	63.4	+6.0	92	21	72	35	1	55	29	56	53	77	1.02	−2.0	7	8,437	sw.	32	s.	12	8	10	13	6.0	.0	.0
Columbia, S. C	351	41	57	29.73	30.12	+.06	61.4	+6.2	89	21	72	30	1	50	33	53	48	69	2.87	−.5	8	6,520	sw.	32	s.	12	10	9	12	5.4	.0	.0
Greenville, S. C	1,039	139	.....	.....	.....	.....	55.4	+5.5	85	21	66	20	1	44	34	.....	.....	.....	2.92	−2.2	8	.....	nw.	.....	.....	.....	12	11	8	.....	.0	.0
Augusta	182	62	77	29.91	30.10	+.04	62.4	+6.4	89	24	74	28	1	51	34	53	46	64	2.07	−2.0	7	5,223	s.	25	w.	12	9	8	14	5.5	.0	.0
Savannah	65	73	152	30.06	30.13	+.07	65.9	+6.9	92	22	76	34	1	55	31	57	53	76	1.91	−1.2	7	8,845	s.	40	nw.	12	11	11	9	4.9	.0	.0
Jacksonville	43	86	110	30.10	30.15	+.09	68.8	+6.2	91	23	79	32	1	59	33	60	56	75	1.13	−1.8	3	6,401	sw.	41	sw.	12	14	11	6	4.0	.0	.0
Florida Peninsula							75.4	+3.2										76	0.35	−1.7									3.1		
Key West	22	10	64	30.08	30.10	+.05	75.2	+2.6	87	28	81	57	1	70	16	68	66	77	.30	−1.1	2	7,790	e.	23	se.	10	23	7	1	2.6	.0	.0
Miami	25	124	168	30.12	30.15	+.07	72.8	+2.6	84	27	78	50	1	67	25	68	63	75	.22	−2.0	2	7,638	se.	25	s.	12	13	11	7	4.6	.0	.0
Tampa	35	88	197	30.11	30.15	+.08	71.3	+4.5	88	20	82	40	1	61	29	62	59	76	.52	−1.9	2	8,187	s.	38	sw.	12	24	7	0	2.2	.0	.0
Titusville	43	5	36	30.09	30.14	.....	69.4	.....	92	24	82	36	1	57	37	.....	.....	.....	1.19	.....	3	.....	se.	.....	.....	.....	14	13	4	.....	.0	.0
East Gulf States							62.9	+5.4										76	6.29	+1.1									6.1		
Atlanta[1]	1,173	128	135	29.07	30.10	+.04	57.6	+5.6	84	23	69	23	1	46	36	51	47	74	5.23	−.1	13	7,098	s.	35	nw.	12	8	7	16	6.3	.0	.0
Macon	370	79	87	29.73	30.12	+.08	62.0	+5.3	88	23	74	24	1	50	35	53	47	67	3.14	−1.8	8	5,753	sw.	24	sw.	12	11	6	14	5.5	.0	.0
Thomasville	273	49	58	29.86	30.15	+.09	64.6	+4.4	88	23	75	28	1	54	33	58	56	81	3.28	−.8	6	.....	sw.	.....	.....	.....	11	3	17	.....	.0	.0
Apalachicola	35	11	51	30.11	30.14	.....	64.4	.....	80	24	70	36	1	59	24	61	.....	.....	1.00	−3.2	3	.....	s.	.....	.....	.....	10	13	8	.....	.0	.0
Pensacola	56	149	185	30.06	30.12	+.06	63.8	+3.5	78	26	69	36	1	58	27	61	59	89	1.67	−3.1	8	9,697	s.	42	nw.	12	11	10	10	5.0	.0	.0
Anniston	741	9	.....	.....	.....	.....	60.5	+8.0	86	23	72	24	1	49	35	.....	.....	.....	5.15	−.5	11	.....	s.	.....	.....	.....	12	7	12	.....	.0	.0
Birmingham	700	11	48	29.32	30.08	+.02	61.2	+5.8	85	23	71	32	13	51	35	53	48	70	11.22	+5.5	14	7,021	s.	32	s.	4	6	12	13	6.2	T	.0
Mobile	57	125	161	30.04	30.10	+.04	63.8	+4.1	86	26	71	33	1	57	27	59	57	85	11.23	+5.2	10	7,917	s.	31	nw.	12	9	9	13	5.9	.0	.0
Montgomery	218	92	105	29.86	30.11	+.05	63.0	+5.2	85	21	73	30	1	53	30	56	52	74	5.97	.0	11	6,165	s.	25	w.	12	6	8	17	6.7	.0	.0
Meridian	375	67	92	29.68	30.08	+.03	63.3	+6.2	86	22	74	29	1	53	34	55	51	72	9.84	+4.6	12	6,367	sw.	26	s.	4	6	15	10	6.1	.0	.0
Vicksburg	247	65	73	29.80	30.06	+.02	64.0	+5.5	86	27	74	34	1	55	31	57	52	72	8.18	+2.6	11	7,178	s.	24	s.	11	5	10	16	6.7	T	.0
New Orleans	53	76	84	30.03	30.08	+.04	68.1	+5.3	84	26	76	39	1	60	23	62	59	81	9.62	+4.9	10	5,835	se.	22	se.	4	5	13	13	6.6	.0	.0
West Gulf States							64.3	+5.1										72	3.42	+0.6									6.0		
Shreveport	249	92	227	29.74	30.01	−.01	64.4	+6.1	89	27	75	38	12	54	32	56	51	68	2.99	−1.1	11	10,435	s.	32	n.	12	8	15	8	5.7	.0	.0
Bentonville	1,303	11	44	28.69	29.93	−.08	54.1	+6.8	77	23	64	20	7	44	41	.....	.....	.....	10.95	+7.4	14	6,721	s.	30	sw.	23	7	7	17	.....	.0	.0
Fort Smith	457	79	94	29.48	29.96	−.05	58.4	+5.8	82	23	69	27	7	48	40	51	45	66	8.98	+6.0	11	7,258	e.	32	w.	6	7	11	13	6.4	.0	.0
Little Rock	357	94	102	29.63	30.01	−.02	59.6	+6.6	85	25	70	34	7	50	32	52	46	66	6.09	+1.5	11	7,885	s.	30	sw.	20	6	7	18	6.8	.0	.0
Austin	605	136	148	29.33	29.96	.....	66.5	+5.8	89	25	77	41	7	56	32	57	50	65	1.02	−1.3	7	7,894	s.	30	nw.	11	5	11	15	6.4	.0	.0
Brownsville	57	88	96	29.87	29.93	.....	71.4	+3.2	84	27	79	46	13	64	30	65	63	82	.88	−.4	6	10,699	se.	38	e.	30	9	15	7	5.5	.0	.0
Corpus Christi	20	11	78	29.94	29.96	−.02	69.0	+4.0	84	4	75	48	13	63	23	64	61	82	2.06	+.5	7	10,565	s.	31	s.	10	6	10	15	6.4	.0	.0
Dallas	512	220	227	29.41	29.95	.....	62.4	.....	84	19	72	30	7	52	32	54	48	64	.74	−2.1	6	11,012	s.	40	sw.	4	5	10	16	7.0	.0	.0
Fort Worth	679	92	110	29.24	29.95	−.03	63.4	+5.7	87	26	74	31	7	53	34	.....	.....	.....	1.40	−.9	6	9,667	s.	35	n.	6	16	6	9	4.3	.0	.0
Galveston	54	106	114	29.96	30.02	+.01	66.0	+3.6	77	27	70	46	12	61	15	62	60	86	1.00	−1.7	6	9,188	s.	34	w.	31	8	10	13	6.1	.0	.0
Houston	138	292	314	29.87	30.02	.....	67.2	+3.9	89	27	76	43	12	59	29	.....	.....	.....	3.49	.0	6	10,700	s.	35	nw.	31	5	14	12	5.9	.0	.0
Palestine	510	64	72	29.46	30.00	.00	64.0	+4.9	88	25	74	34	7	54	31	57	52	70	2.59	−.9	5	8,249	s.	27	sw.	16	6	16	9	5.9	.0	.0
Port Arthur	34	58	66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
San Antonio	693	242	301	29.22	29.94	−.04	67.3	+4.5	92	27	78	42	12	57	30	58	53	68	2.31	+.5	8	10,366	se.	54	w.	5	5	14	12	6.2	.0	.0

[1] Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, March 1935*—Continued

[Compiled by Annie E. Small, by official authority, U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In
Ohio Valley and Tennessee							51.9	+7.6										70	5.61	+1.4										6.9		
Chattanooga	762	71	214	29.27	30.09	+0.03	59.0	+7.8	86	22	70	28	1	48	35	51	45	67	7.54	+1.8	14	7,227	s.	34	nw.	25	6	14	11	6.0	1.4	0.0
Knoxville	995	66	84	29.02	30.08	+0.02	56.0	+7.3	83	21	67	25	1	45	39	49	46	77	7.85	+2.8	17	5,047	sw.	25	se.	6	5	14	12	6.3	1.6	.0
Memphis	399	78	86	29.60	30.02	−.02	59.0	+6.7	81	20	68	33	8	50	35	53	49	74	6.30	+1.0	10	6,736	sw.	28	n.	27	7	11	13	6.4	.0	.0
Nashville	546	168	191	29.48	30.07	+.02	57.2	+8.0	87	23	67	30	8	48	36	50	45	70	6.96	+1.8	16	8,747	s.	36	se.	4	2	12	17	7.2	.1	.0
Lexington	989	5																														
Louisville	525	188	234	29.46	30.04	−.01	52.6	+7.2	77	20	61	29	9	44	31	47	42	70	7.26	+2.9	14	8,949	s.	37	w.	16	10	3	18	6.7	1.5	.0
Evansville	431	76	116	29.55	30.02	−.02	52.9	+7.0	79	23	61	30	8	45	31	47	42	71	9.24	+5.0	14	8,568	s.	40	s.	16	5	8	18	6.8	.0	.0
Indianapolis	822	194	230	29.12	30.02	−.02	47.4	+7.4	74	15	56	26	9	38	34	42	36	68	3.49	−.4	17	10,003	sw.	38	w.	17	3	10	18	7.7	T	.0
Terre Haute	575	96	129	29.37	29.99		49.8		77	23	59	26	8	40	38	43	38	72	4.47	+.7	14	8,737	s.	37	s.	15	4	9	18	7.3	T	.0
Cincinnati	627	11	51	29.34	30.03	−.02	49.4	+8.5	74	15	58	25	9	41	33	44	38	70	6.03	+2.1	17	7,048	s.	28	w.	16	7	4	20	7.4	.1	.0
Columbus	822	90	210	29.14	30.03	−.01	47.8	+8.7	72	15	57	25	9	39	36	42	36	68	2.81	−.7	15	8,637	s.	39	sw.	17	6	11	14	6.6	T	.0
Dayton	900	58	153	29.06	30.03		47.9	+7.4	73	15	57	26	18	39	33				3.47	−.2	16	8,185	sw.	32	w.	17	5	9	17		T	.0
Elkins	1,947	59	78	28.00	30.09	+.04	47.1	+7.1	78	16	58	20	1	36	46	41	35	69	5.91	+2.1	20	5,686	se.	32	w.	17	6	7	18	7.3	6.2	.0
Parkersburg	637	77	84	29.41	30.08	+.03	50.4	+7.6	78	16	60	23	9	40	42	44	38	67	4.20	+.7	16	5,700	se.	28	sw.	17	4	9	18	7.1	T	.0
Pittsburgh	842	353	410	29.13	30.05	+.01	47.6	+8.0	77	16	57	23	9	38	36	41	35	66	3.04	.0	12	8,291	sw.	38	sw.	17	6	6	19	7.1	1.1	.0
							38.5	+5.5										72	2.11	−0.6										6.7		
Lower Lake Region																																
Buffalo	768	243	280	29.18	30.03	+.01	36.2	+5.1	60	17	44	10	9	29	37	32	28	76	1.85	−.7	16	12,128	sw.	68	sw.	17	7	6	18	6.9	7.3	.0
Canton	448	10	61	29.52	30.02		30.1	+2.4	60	17	39	−4	1	21	42				1.25	−1.2	13	6,955	w.	39	w	17	7	12	12	6.2	2.1	.0
Ithaca	836	77	100	29.13	30.05		36.4	+4.6	72	16	46	0	9	27	38	33	28	72	3.14	+.8	14	7,750	nw.	36	nw.	23	5	8	18	7.1	13.1	.0
Oswego	335	71	85	29.66	30.04	+.03	35.0	+3.8	70	16	42	12	9	28	38	31	25	68	1.19	−1.4	12	8,328	s.	32	w.	17	5	7	19	7.2	1.9	.0
Rochester	523	86	102	29.46	30.04	+.02	37.8	+6.0	70	16	46	9	9	30	40	33	26	66	1.76	−1.0	15	6,993	sw.	44	sw.	17	8	7	16	6.4	4.3	T
Syracuse	596	65	79	29.40	30.05	+.03	37.6	+6.2	71	16	45	10	9	30	39				2.63	−.4	17	5,888	w.	26	sw.	17	6	12	13	6.2	5.5	.0
Erie	714	130	166	29.24	30.03	+.01	39.7	+6.2	72	16	48	14	9	32	38	35	30	72	2.21	−.4	15	10,966	ne.	44	sw.	17	6	12	13	6.7	1.4	.0
Cleveland	762	267	337	29.18	30.02	−.01	43.2	+8.6	72	16	52	18	8	34	40	37	31	70	2.06	−.6	15	12,187	s.	46	s.	16	5	11	15	6.7	T	.0
Sandusky	629	5	67	29.34	30.03	.00	42.8	+7.7	74	15	52	18	9	33	39				2.07	−.6	14	8,386	sw.	35	sw.	29	4	12	15	7.0	T	.0
Toledo	628	79	87	29.33	30.03	.00	41.4	+6.1	72	15	50	19	9	33	35	36	32	74	1.98	−.6	18	8,213	e.	32	w.	17	9	10	12	6.0	.7	.0
Fort Wayne	857	69	84	29.07	30.01		42.7	+3.8	74	15	52	21	9	34	36	38	34	76	3.34	+.1	15	8,447	sw.	35	w.	17	4	12	15	7.3	.1	.0
Detroit [1]	626	5	78	29.32	30.02	−.01	39.2	+5.8	69	15	48	7	9	30	33	34	30	77	1.85	−.6	12	8,397	sw.	40	sw.	17	5	13	13	6.3	4.4	.0
							32.8	+4.5										79	2.08	−0.1										7.0		
Upper Lake Region																																
Alpena	609	13	89	29.34	30.02	−.01	30.5	+5.0	55	16	38	8	9	23	26	27	24	79	2.51	+.5	10	8,285	nw.	37	se.	20	5	14	12	6.3	6.8	.0
Escanaba	612	54	60	29.31	30.00	−.04	28.7	+4.5	54	21	36	9	3	22	24	26	22	79	1.37	−.5	10	7,166	s.	30	e.	20	4	13	14	6.9	3.8	.0
Grand Rapids	707	70	244	29.21	30.00	−.03	38.2	+4.8	70	15	46	14	8	30	32	34	29	73	2.62	+.1	14	9,188	sw.	42	sw.	15	3	13	15	7.0	7.3	.0
Lansing	878	6	88	29.04	30.00		37.0	+4.8	66	15	46	10	9	28	31	34	32	86	3.28	+.9	15	7,999	sw.	30	w.	17	6	12	13	6.6	8.7	.0
Ludington	637	5	54	29.28	29.99		34.1	+4.0	61	15	40	15	8	28	28	31			1.24	−1.0	11		se.				4	9	18		4.5	.0
Marquette	734	77	111	29.16	29.98	−.06	29.2	+4.4	53	21	35	12	14	23	21	27	24	82	1.67	−.6	12	7,715	w.	33	se.	20	5	13	13	6.8	7.4	T
Sault Sainte Marie	614	11	52	29.31	30.03	.00	25.6	+4.0	46	21	34	0	2	18	30	23	20	80	2.12	+.3	17	6,569	se.	28	se.	21	3	14	14	7.0	13.9	.2
Chicago	673	7	131	29.26	29.99	−.04	41.3	+6.0	72	15	49	22	12	34	31	37	33	74	3.48	+.9	13	8,944	sw.	29	sw.	5	7	6	18	6.9	4.5	.0
Green Bay	617	109	141	29.29	29.97	−.07	33.1	+4.5	59	15	40	13	3	26	27	29	25	75	.70	−1.3	8	8,587	w.	30	se.	20	3	6	22	7.5	9.2	.0
Milwaukee	681	97	221	29.23	29.98	−.05	37.6	+5.5	68	15	44	18	12	31	30	34	29	74	1.98	−.4	11	10,001	w.	39	se.	20	3	6	22	7.5	9.2	.0
Duluth	1,133	5	47	28.67	29.93	−.13	25.4	+1.7	46	21	32	1	12	18	23	23	21	85	2.04	+.5	10	9,873	ne.	48	nw.	15	7	4	20	7.0	4.2	.5
							26.0	+3.6										78	0.85	0.0										6.4		
North Dakota																																
Moorhead, Minn	940	50	58	28.87	29.91	−.17	28.2	+5.5	64	14	37	0	6	20	36	25	21	77	1.00	.0	6	8,205	s.	29	n.	15	3	16	12	7.0	4.8	.0
Bismarck	1,674	8	57	28.06	29.90	−.16	27.6	+3.4	72	14	38	−17	7	17	34	24	19	73	.99	+.1	8	8,357	nw.	38	sw.	26	7	12	12	5.9	9.0	.0
Devils Lake	1,478	11	44	28.28	29.90	−.15	22.7	+2.9	56	14	31	−11	7	14	27	21	19	87	.87	+.1	8	8,495	se.	32	nw.	26	3	10	18	7.4	5.1	T
Grand Forks	833	12	67				25.4		57	14	33	3	6	18	31	23			.99		8		nw.	34	nw.	27	2	17	12		4.6	T
Williston	1,878	41	48	27.86	29.90	−.14	25.7	+2.8	65	14	37	−26	7	15	43	22	18	76	.54	−.2	3	7,464	nw.	39	nw.	26	10	12	9	5.3	5.8	.0
							42.6	+6.3										75	3.40	+1.0										6.8		
Upper Mississippi Valley																																
Minneapolis	918	102	208	28.92	29.92	−.13	34.0	+4.4	69	26	42	12	7	26	31	30	26	72	1.63	+.2	6	9,145	w.	32	se.	20	6	6	19	6.9	4.6	.0
La Crosse	714	11	48	29.16	29.95	−.09	36.6	+5.1	68	15	46	9	8	28	30	33	29	77	1.69	+.1	9	5,252	s.	21	s.	15	3	9	19	7.5	6.9	.0
Madison	974	70	78	28.89	29.97	−.07	36.0	+5.4	65	15	44	13	8	28	35	33	30	80	1.58	−.5	13	7,470	nw.	27	ne.	16	3	10	18	7.4	8.4	.0
Charles City	1,015	10	51	28.85	29.96	−.09	36.6	+5.9	71	15	45	1	8	28	32	33	29	79	1.41	−.4	8	6,751	se.	35	sw.	28	7	15	9	5.6	8.3	.0
Davenport	606	68	161	29.31	29.98	−.05	42.2	+6.1	72	15	51	14	8	34	36	38	33	73	3.49	+1.2	12	8,328	ne.	37	sw.	15	7	6	18	6.9	8.8	.0
Des Moines	861	5	99	29.03	29.95	−.09	41.7	+5.8	79	22	50	11	7	33	37	37	32	74	1.10	−.7	10	8,410	se.	35	s.	15	7	13	11	6.1	6.3	.0
Dubuque	700	60	79	29.20	29.96	−.08	39.4	+5.4	71	15	48	10	8	31	36	35	30	73	2.32	+.3	13	5,459	s.	21	n.	16	7	5	19	7.0	8.8	.0
Keokuk	614	64	78	29.30	29.98	−.05	45.7	+6.8	77	20	55	15	8	37	37	40	35	71	2.97	+.6	10	7,181	sw.	27	sw.	15	6	8	17	6.9	1.6	.0
Cairo	358	87	93	29.63	30.01	−.03	55.2	+8.0	81	23	64	28	8	46	30	49	45	74	12.00	+8.2	14	8,376	s.	33	n.	11	4	8	19	7.2	.0	.0
Peoria	609	11	45	29.32	29.99	−.04	44.3	+7.3	77	15	54	20	8	35	33	40	36	77	3.32	+.6	13	7,007	s.	26	sw.	15	8	4	19	6.6	.1	.0
Springfield, Ill	636	5	191	29.29	29.97	−.06	48.0	+7.8	80	20	57	21	8	38	35	43	40	78	2.90	−.3	10	9,913	s.	38	s.	4	5	10	16	7.1	1.3	.0
St. Louis	568	265	303	29.36	29.97	−.06	51.2	+7.4	81	20	61	23	8	42	37	46	41	74	6.43	+3.0	10	10,863	sw.	51	s.	4	7	10	14	6.4	.0	.0
							46.4	+7.8										64	2.02	+0.1										5.4		
Missouri Valley																																
Columbia, Mo	784	6	84	29.11	29.96	−.07	50.1	+7.5	81	20	60	20	7	41	41				2.88	−.1	9	7,808	sw.	34	sw.	15	5	10	16	6.4	1.6	.0
Kansas City [1]	750	32	45	29.12	29.94	−.08	51.2	+8.5	83	22	62	16	7	41	40	43	36	63	.69	−1.8	4	9,270	sw.	39	sw.	15	10	9	12	5.6	T	.0
St. Joseph	967	11	49	28.89	29.93		49.0		84	22	60	12	7	39	40	41	33	63	1.61	−.4	9	8,018	sw.	41	nw.	25	14	7	10	5.2	.1	.0
Springfield, Mo	1,324	98	104	28.55	29.96	−.06	52.8	+7.6	77	20	62	20	7	43	43	46	42	71	9.09	+5.7	12	9,404	s.	32	sw.	15	11	8	12	5.6	T	.0
Iola	984	11	50	28.87	29.92	−.09	53.7	+9.2	82	14	65	17	7	42	38				1.63	−1.0	6		s.				4	11	16		2.8	.0
Topeka	987	65	87				51.0	+8.4	87	22	62	13	7	40	42				.32	−1.8	5	8,693	s.	32	sw.	15	9	13	9	5.2	.1	.0
Lincoln	1,189	11	81	28.63	29.92	−.10	45.0	+7.5	84	15	56	7	7	34	45	37	29	61	.96	−.3	4	8,828	n.	32	w.	4	12	7	12	5.2	6.9	.0
Omaha	1,105	170	200	28.74	29.94	−.10	44.4	+7.4	82	15	55	7	7	34	43	37	28	59	1.10	−.3	4	9,879	s.	39	s.	20	12	7	12	5.2	11.5	.0
Valentine	2,598	47	54	27.16	29.91	−.12	38.2	+5.9	76	14	51	8	6	26	56	31	21	57	1.29	+.3	8	8,273	w.	31	nw.	20	11	10	10	5.1	9.6	6.0
Sioux City	1,138	64	106	28.69	29.92	−.13	41.0	+8.3	85	15	51	6	7	31	51	34	28	66	1.32	+.2	7	8,634	se.	37	nw.	20	8	11	12	5.9	6.9	T
Huron	1,306	60	74	28.48	29.91	−.15	36.2	+7.3	75	14	46	4	6	26	39	31	26	71	1.36	+.4	6	8,430	se.	39	nw.	4	13	9	9	4.8	.9	1.2
							32.4	+1.1										62	1.04	0.0										6.2		
Northern Slope																																
Billings	3,570	17	31																													
Havre	2,505	11	67	27.22	29.93	−.07	26.2	−.9	69	14	36	−17	7	17	37	22	17	71	.92	+.4	9	7,715	sw.	37	sw.	26	6	14	11	6.2	8.8	.7
Helena	4,124	85	111	25.63	29.91	−.10	30.2	−2.2	67	14	40	−6	5	21	36	25	16	59	1.14	+.4	9	7,020	sw.	32	sw.	25	4	8	19	7.1	24.3	1.8
Kalispell	2,973	48	56	26.80	29.90	−.09	31.9	−1.0	57	13	39	11	6	24	25	28	24	73	1.18	+.2	17	5,214	sw.	25	s.	24	2	10	19	7.5	7.6	T
Miles City	2,371	48	55	27.34	29.94	−.08	30.9	+2.3	75	14	42	−5	7	20	40	27	21	71	1.65	+.8	14	5,541	s.	37	nw.	26	6	16	9	5.7	15.7	.4
Rapid City	3,259	50	58	26.44	29.92	−.09	36.2	+3.6	78	14	48	−2	6	24	43	29	20	59	1.27	+.3	5	7,139	n.	34	nw.	26	5	17	9	5.8	9.4	2.0
Cheyenne	6,094	50	71	23.83	29.87	−.09	35.1	+2.0	69	14	48	12	6	22	44	27	17	51	.32	−.7	7	11,018	w.	46	w.	29	7	15	9	5.6	2.6	T
Lander	5,372	60	68	24.46	29.87	−.12	32.8	+.4	66	14	45	6	6	20	39	26	15	52	.50	−.7	4	5,546	sw.	34	sw.	15	12	14	5	4.6	4.2	.0
Sheridan	3,790	10	47	25.93	29.90		32.0		75	14	45	3	6	19	47	26	18	62	1.40	+.2	10	5,108	nw.	32	nw.	25	10	10	11	5.8	15.3	3.7
Yellowstone Park	6,241	11	48	23.69	29.94	−.08	25.6	−.9	52	14	34	3	6	17	34	22	17	72	1.41	−.3	20	7,666	sw.	41	sw.	25	3	5	23	8.2	25.5	6.8
North Platte	2,821	11	51	26.94	29.89	−.11	42.8	+6.2	80	14	56	9	7	30	50	33	22	55	.56	−.3	7	6,701	w.	35	n.	15	6	13	12	5.8	2.3	.0

[1] Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, March 1935*—Continued

[Compiled by Annie E. Small, by official authority, U. S. Weather Bureau]

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Middle Slope							49.6	+6.3										48	1.07	−0.2										5.1		
Denver	5,292	106	113	24.56	29.82	−0.13	43.6	+4.3	78	14	56	20	6	31	45	32	14	36	0.23	−0.8	2	7,014	s.	32	w.	15	8	17	6	5.1	3.0	0.0
Pueblo	4,685	80	86	25.14	29.82	−.10	45.6	+4.0	79	14	60	18	7	31	47	33	14	33	.14	−.4	1	7,437	nw.	38	nw.	20	19	10	2	3.6	1.5	.0
Concordia	1,392	50	58	28.45	29.94	−.07	48.4	+7.4	84	15	60	10	6	37	44	39	28	53	.47	−.8	4	8,078	s.	32	n.	15	11	12	8	4.7	3.6	.0
Dodge City	2,509	10	86	27.30	29.91	−.06	50.4	+7.6	81	15	63	19	7	38	36	39	26	47	.84	.0	5	10,710	s.	42	nw.	15	12	10	9	4.9	.5	.0
Wichita	1,358	85	93	28.47	29.91	−.08	52.4	+7.3	83	14	62	16	7	43	35	44	34	56	.98	−.8	6	10,016	sw.	40	sw.	15	12	8	11	5.4	1.0	.0
Oklahoma City	1,214	10	47	28.64	29.92	−.06	57.2	+7.2	83	26	67	21	7	47	34	48	41	63	3.77	+1.8	7	8,980	s.	38	sw.	22	6	6	19	7.2	T	.0
Southern Slope							59.9	+5.4										45	1.16	+0.3										5.8		
Abilene	1,738	10	52	28.12	29.92	−.04	62.9	+6.4	88	24	75	31	7	51	34	50	38	50	.59	−.7	3	9,120	s.	33	s.	15	8	10	13	5.8	T	.0
Amarillo	3,676	10	49	26.16	29.88	−.07	53.1	+6.2	80	26	66	22	7	40	39	39	23	38	1.14	+.4	4	8,381	sw.	29	sw.	4	10	8	13	5.7	4.9	.0
Big Spring	2,537	5	62	27.31	29.92	.....	59.8	.....	88	24	72	32	12	47	40	47	36	50	1.33	.....	3	.....	s.	.....	.....	.....	7	8	16	6.4	T	.0
Del Rio	944	64	71	28.90	29.88	−.07	68.4	+4.9	95	25	79	41	12	58	34	56	46	53	2.34	+1.6	2	7,816	se.	57	w.	21	10	8	13	5.7	.0	.0
Roswell	3,566	75	85	26.29	29.88	−.02	55.2	+3.9	80	18	69	26	12	41	44	40	21	32	.57	−.2	1	7,121	s.	43	w.	3	9	11	11	5.3	3.2	.0
Southern Plateau							49.6	−1.2										46	0.35	−0.2										4.6		
El Paso	3,778	152	175	26.13	29.89	+.01	58.6	+2.8	81	14	71	30	11	47	34	43	24	30	.14	−.2	2	8,651	w.	38	w.	15	11	14	6	4.5	1.2	.0
Albuquerque	4,972	5	39	24.97	29.87	.....	46.2	.....	73	29	62	16	6	30	45	34	19	38	.03	−.4	1	7,486	w.	40	w.	15	9	11	11	5.5	T	.0
Santa Fe	7,013	38	53	23.16	29.89	.00	40.8	+1.1	65	13	52	16	6	29	33	32	22	48	.06	−.7	2	5,943	n.	25	n.	15	10	8	13	5.5	.2	.0
Flagstaff	6,907	10	59	23.25	29.89	−.02	32.9	−3.0	63	29	46	−2	6	19	48	28	.....	67	1.91	.....	9	6,845	sw.	29	sw.	8	9	13	9	.....	16.2	.0
Phoenix	1,108	10	107	28.78	29.95	+.04	57.6	−3.1	85	28	70	34	11	45	35	47	36	52	1.39	+.7	5	4,310	e.	18	w.	15	12	7	12	4.6	.0	.0
Yuma	141	9	54	29.80	29.96	+.02	61.4	−2.7	88	28	76	37	20	47	40	48	32	38	.11	−.2	1	5,043	w.	27	nw.	19	19	11	1	2.8	.0	.0
Independence	3,957	5	26	[illegible]	29.95	+.01	46.2	−2.3	79	29	60	17	22	32	41	34	.....	.....	.35	−.2	5	.....	s.	.....	.....	.....	18	3	10	.....	T	.0
Middle Plateau							38.7	−2.2										55	1.01	−0.1										5.1		
Reno	4,527	61	76	25.40	29.99	+.01	37.9	−3.1	74	13	50	13	9	26	42	31	23	59	.81	.0	8	5,855	w.	32	sw.	14	16	7	8	4.0	8.0	.0
Tonopah	6,090	12	20	.....	.....	.....	35.8	.....	64	31	47	11	10	25	35	29	18	51	.32	.....	5	.....	se.	.....	.....	.....	.....	.....	.....	.....	.....	.....
Winnemucca	4,344	18	56	25.54	29.98	−.03	36.0	−4.0	71	13	50	9	4	22	44	30	22	61	1.08	+.1	7	6,530	sw.	35	nw.	14	10	5	16	5.6	14.0	.0
Modena	5,473	10	46	24.51	29.90	−.06	36.3	−1.9	67	29	49	11	10	24	46	30	20	58	1.21	+.2	10	8,098	sw.	43	s.	21	15	7	9	4.5	11.2	.0
Salt Lake City	4,537	86	210	25.53	29.93	−.05	41.0	−.7	70	14	50	21	10	32	31	33	23	53	1.35	−.6	10	6,365	s.	37	nw.	15	9	5	17	6.2	7.8	.0
Grand Junction	4,602	60	68	25.28	29.86	−.08	42.2	−1.4	69	29	55	17	6	30	41	33	20	46	.60	−.2	5	5,545	se.	30	w.	15	9	12	10	5.1	3.4	.0
Northern Plateau							39.0	−2.3										60	0.83	−0.3										6.8		
Baker	3,471	48	53	26.35	29.98	−.05	33.8	−3.8	63	13	44	7	5	24	31	30	24	66	.94	−.2	11	5,054	se.	27	sw.	25	6	11	14	6.5	7.8	T
Boise	2,739	79	87	27.10	30.00	−.03	39.8	−2.9	70	13	49	23	9	31	32	34	26	59	.68	−.7	8	5,197	se.	30	nw.	25	6	6	19	7.1	2.7	.0
Pocatello	4,477	60	68	25.35	29.92	−.09	35.9	−1.5	61	14	44	15	9	28	24	31	23	59	1.06	−.2	11	8,605	sw.	35	sw.	15	3	11	17	7.1	10.5	.0
Spokane	1,929	101	110	27.85	29.93	−.08	38.3	−1.4	64	13	46	24	30	31	25	34	27	67	.78	−.4	12	6,178	s.	26	sw.	25	5	8	18	7.2	.6	T
Walla Walla	991	57	65	28.87	29.95	−.07	44.0	−2.1	71	13	52	28	2	36	26	38	29	55	1.15	−.5	14	5,633	s.	27	se.	6	6	11	14	6.8	1.1	.0
Yakima	1,076	58	67	28.77	29.94	.....	41.9	−2.2	67	13	52	23	21	32	35	35	25	54	.37	.0	8	4,929	nw.	32	sw.	24	6	13	12	6.0	1.9	T
North Pacific Coast Region							43.2	−2.2										77	6.06	+1.9										8.2		
North Head	211	11	56	29.76	29.99	−.02	42.0	−3.2	51	13	46	32	4	38	14	40	37	83	9.82	+4.3	28	12,453	s.	60	s.	24	3	8	20	7.7	2.8	.0
Seattle	125	90	321	29.82	29.95	−.04	43.6	−1.3	58	13	49	32	2	38	20	39	35	74	4.03	+1.0	19	8,658	s.	45	sw.	24	0	9	22	8.0	.2	.0
Tatoosh Island	86	10	54	29.82	29.92	−.04	42.1	−.8	50	12	45	34	20	39	10	40	38	85	12.84	+5.0	26	10,643	s.	56	sw.	24	1	5	25	8.7	.7	.0
Medford	1,329	29	58	28.60	30.04	.....	43.4	.....	71	28	54	24	10	32	41	38	31	68	1.26	−.4	10	4,552	nw.	36	se.	6	4	13	14	8.9	T	.0
Portland, Oreg	153	68	106	29.85	30.01	−.01	44.0	−2.9	62	13	50	32	9	38	20	40	36	76	5.28	+1.4	21	5,203	s.	28	s.	24	2	2	27	8.3	T	.0
Roseburg	510	45	76	29.50	30.05	+.01	44.2	−2.9	70	28	54	28	10	35	37	40	35	74	3.16	−.1	14	3,723	sw.	30	sw.	25	3	11	17	7.3	.7	.0
Middle Pacific Coast Region							49.4	−2.8										70	3.61	0.0										5.0		
Eureka	62	73	89	30.03	30.10	+.04	45.3	−3.0	59	12	52	33	8	39	20	43	41	85	5.60	+.4	17	5,882	se.	25	sw.	3	9	8	14	5.7	T	.0
Redding	722	20	34	.....	.....	.....	48.6	.....	82	29	58	32	8	39	30	41	32	59	2.58	.....	13	6,564	nw.	30	se.	22	8	9	14	6.1	.8	.0
Sacramento	66	92	115	29.97	30.04	+.01	50.4	−3.9	77	29	60	35	9	41	30	45	39	68	2.93	+.4	9	6,204	s.	25	n.	15	12	16	3	3.7	T	.0
San Francisco	155	208	243	29.89	30.06	.00	52.6	−1.6	76	28	59	41	21	46	27	46	41	68	2.31	−.8	12	5,703	w.	28	s.	6	13	9	9	4.5	T	.0
South Pacific Coast Region							53.7	−2.7										70	2.70	+0.7										4.8		
Fresno	327	97	105	29.71	30.07	+.06	51.2	−3.8	80	30	61	33	10	41	31	46	40	69	2.36	+.8	8	4,170	nw.	22	nw.	4	10	10	11	4.9	.0	.0
Los Angeles	338	159	191	29.67	30.04	+.02	55.3	−2.2	83	13	63	41	9	47	26	48	42	67	4.31	+1.5	9	4,665	ne.	20	ne.	2	16	6	9	4.2	.0	.0
San Diego	87	62	70	29.95	30.05	+.03	54.6	−2.1	73	13	61	40	10	48	23	50	45	74	1.42	−.3	6	4,938	w.	24	s.	7	12	8	11	5.4	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.98	30.07	.....	74.8	−.6	87	26	80	66	18	70	20	.....	.....	.....	1.18	−2.0	13	11,262	e.	38	ne.	10	11	19	1	4.4	.0	.0
Panama Canal																																
Balboa Heights	118	6	97	.....	[1]29.85	.....	81.8	+.6	93	30	91	70	16	73	22	.....	.....	.....	T	−.7	0	7,524	nw.	26	n.	23	12	19	0	.....	.0	.0
Cristobal	36	6	97	.....	[1]29.89	.....	81.4	−.1	86	9	85	76	26	78	9	.....	.....	.....	.80	−.7	16	11,292	n.	26	n.	10	11	17	3	.....	.0	.0
Alaska																																
Fairbanks	454	11	87	[2]29.54	[2]30.10	.....	4.6	.....	42	31	20	−39	25	−11	47	5	−2	68	1.97	.....	12	4,049	ne.	30	w.	22	14	8	9	4.6	30.0	32.0
Juneau	80	96	116	[2]29.80	[2]29.89	.....	28.0	.....	45	16	33	8	5	23	19	25	15	58	3.22	.....	12	6,583	ne.	34	ne.	2	12	6	13	5.5	24.6	.2
Hawaiian Islands																																
Honolulu	38	86	100	[1]29.94	[1]29.98	.....	71.8	+.4	81	21	77	60	17	67	16	66	64	77	2.94	−.3	14	5,911	e.	30	e.	13	6	13	12	6.3	.0	.0

[1] Observations taken bihourly.

[2] Pressure not reduced to mean of 42 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, March 1935*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+ mean min. ÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99				23.7		29.5	17.9	37	0	3.49		29.7
Sydney, Cape Breton Island	48	29.76	29.81	−0.07	23.3	−2.9	32.2	14.5	56	−2	3.81	−1.12	29.5
Halifax, Nova Scotia	240				28.3	−.7	34.3	22.4	51	4	3.40	−2.06	3.5
Yarmouth, Nova Scotia	65	29.83	29.90	−.05	31.3	+.5	36.8	25.9	47	7	3.16	−1.84	9.8
Charlottetown, Prince Edward Island	38	29.78	29.82	−.08	21.9	−3.5	29.6	14.2	52	−10	2.21	−1.00	14.0
Chatham, New Brunswick	28	29.77	29.81	−.09	22.1	−.9	32.9	11.3	52	−20	1.50	−1.97	12.5
Father Point, Quebec	20	29.88	29.91	+.01	20.5	+.2	28.4	12.6	40	−8	.75	−1.98	7.0
Quebec, Quebec	296												
Doucet, Quebec	1,236				9.8		25.8	−6.2	42	−44	3.16		30.6
Montreal, Quebec	187												
Ottawa, Ontario	236												
Kingston, Ontario	285												
Toronto, Ontario	379	29.62	30.04	+.02	35.5	+8.2	43.2	27.9	68	10	1.25	−1.39	2.3
Cochrane, Ontario	930				14.8		26.0	3.6	40	−25	2.73		27.3
White River, Ontario	1,244	28.61	29.97	−.06	16.5	+4.3	29.7	3.3	43	−30	2.39	+1.01	23.9
London, Ontario	808												
Southampton, Ontario	656	29.27	30.00	−.03	31.4	+6.7	39.3	23.4	60	6	2.12	−.53	6.5
Parry Sound, Ontario	688	29.29	30.00	−.02	28.0	+6.9	34.6	19.6	49	−6	2.80	+.27	5.5
Port Arthur, Ontario	644	29.22	29.95	−.10	24.0	+7.2	31.7	16.4	48	−3	1.91	+.94	19.1
Winnipeg, Manitoba	760												
Minnedosa, Manitoba	1,690	28.02	29.91	−.15	15.5	+3.0	24.3	6.6	41	−12	2.30	+1.65	21.5
Le Pas, Manitoba	860		29.96		9.8		20.6	−.9	48	−17	1.82		18.2
Qu'Appelle, Saskatchewan	2,115												
Moose Jaw, Saskatchewan	1,759				19.0		27.5	10.5	50	−22	1.15		11.5
Swift Current, Saskatchewan	2,392												
Medicine Hat, Alberta	2,365												
Calgary, Alberta	3,540												
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450												
Battleford, Saskatchewan	1,592												
Edmonton, Alberta	2,150												
Kamloops, British Columbia	1,262	28.58	29.90	−.02	36.7	+.6	45.5	27.9	62	14	.52	−.05	3.8
Victoria, British Columbia	230												
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20				39.6		45.2	34.1	50	27	14.77		39.2
Prince Rupert, British Columbia	170												
Hamilton, Bermuda	151				34.5		39.9	29.1	45	18	3.35		20.7

LATE REPORTS FOR FEBRUARY 1935

Cape Race, Newfoundland	99				22.7		29.3	16.2	40	−5	5.23		28.7
Sydney, Cape Breton Island	48	29.81	29.86	−0.06	17.8	−1.5	27.1	8.5	40	−12	3.70	−0.39	31.0
Halifax, Nova Scotia	240				21.2	−1.2	28.0	14.5	4	−20	3.62	−1.54	7.4
Yarmouth, Nova Scotia	65	29.81	29.88	−.11	26.6	+.8	33.0	20.1	43	−6	4.59	+.42	25.2
Charlottetown, Prince Edward Island	38	29.81	29.85	−.10	13.9	−3.7	22.5	5.2	40	−13	4.52	+1.46	42.4
Chatham, New Brunswick	28	29.79	29.83	−.13	10.0	−2.5	21.8	−1.7	37	−32	2.20	−0.6	21.4
Father Point, Quebec	20	29.89	29.92	−.06	9.4	−2.1	18.4	.3	35	−16	.98	−1.23	9.8
Quebec, Quebec	296	29.65	29.99	.00	10.9	−.9	18.9	3.0	36	−12	2.31	−.96	23.1
White River, Ontario	1,244	28.66	30.05	+.03	4.6	+4.4	19.4	−10.3	39	−46	.96	−.56	9.6
Minnedosa, Manitoba	1,690	28.22	30.13	+.04	14.6	+17.3	24.3	4.9	41	−24	.06	−.55	.6
Le Pas, Manitoba	860		30.09		12.8		23.6	2.1	44	−28	.20		2.0
Calgary, Alberta	3,540	26.33	30.10	+.11	30.6	+17.1	41.4	19.8	60	−8	.54	−.09	5.4
Banff, Alberta	4,521	25.46	30.20	+.22	25.7	+6.5	36.4	15.1	47	−2	.74	−.18	7.3
Edmonton, Alberta	2,150	27.74	30.10	+.08	24.8	+16.5	34.5	15.2	53	−8	.18	−.49	1.8
Kamloops, British Columbia	1,262	28.90	30.23	+.27	34.8	+6.5	41.1	28.5	55	−18	.15	−.64	1.0
Estevan Point, British Columbia	20				44.2		50.0	38.4	62	30	8.94		.0
Price Rupert, British Columbia	170				40.0		45.3	34.8	53	28	3.50		.0

SEVERE LOCAL STORMS, MARCH 1935

[Compiled by Mary O. Souder]

[The table herewith contains such data as have been received from U. S. Weather Bureau stations concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
San Pedro, Calif.	2	A. m.-1:50 p. m.	33		$15,000	Squall	Property damaged; shrubs and trees uprooted; pillars twisted out of porches; 3 garages completely wrecked; no injuries reported.
Isabel and Pratt, Kans.	3	9 p. m	30		900	Wind and rain	Chief damage to barns and small farm buildings.
Wichita, Kans., vicinity of	3	P. m.				Tornadic winds	Number of buildings damaged.
Minnesota and Wisconsin	3-5		[1] 50	2	650,000	Sleet and glaze	Area extended from Beaver Bay, Minn., to slightly beyond Ashland, Wis., from Swan Lake, Minn., to Lawler, Minn., and from Moose Lake, Minn., to Solon Springs, Wis.; most destructive sleet and glaze storm ever experienced at Duluth; trees, poles and wires down; street cars halted and wire communication completely paralyzed.
Crossett, Ark., 9 miles east	4	P. m.		0	500	Tornado	Damage to Crossett Camp buildings; path narrow.
Forney, Tex., and vicinity	4	4:30 a. m.	880	1	100,000	do	15 persons injured; more than 50 percent of property loss estimated was in the business district; loss to residential property slight except in negro section where damage was heavy due to poor construction and bad condition of dwellings; path 10 miles long.
San Antonio, Tex.	5	6:25-6:38 p. m.	2,640		1,005,000	Hail	This storm one of the most destructive in the history of the city; buildings and houses damaged; loss to gardens and flowers $5,000; path about 6 miles long.
Cleburne County, Ala.	5-6				600	Wind	Roofs and barns damaged.
Palestine, Tex., and vicinity	6	8:30 a. m.	[1] 3			Wind and hail	Automobile tops and roofs of buildings damaged.
Lincoln and Warren Counties, Ga.	6	4 p. m.	100	1	35,000	Tornado	Property damaged; path 20 miles long.
Geneva and Houston Counties, Ala.	6				9,000	Tornadic winds	The storm struck eastern portion of Geneva and western Houston Counties in a southeasterly direction into Florida; 22 persons injured.
Pike County, Ala.	6					Wind	Some damage reported at various places in this county.
Sebewaing, Mich., and vicinity	6-7				175,000	Flood	Sebewaing located on Sebewaing River; much property damage as a result of an ice-jam combined with the sudden spring thaw.
Russellville, Ark., 7 miles northeast.	10	8 p. m.	667	0	21,000	Tornado	4 persons injured; $20,000 damage to property; $1,000 loss to fruit trees.
Havana, Ark.	10	11 p. m.	200	0	1,000	do	Property damaged.
Springfield, Mo.	10-11				2,000	Excessive rain	Streets, sewers, and basements flooded; traffic suspended on numerous highways; loss to livestock.
White, Black, and St. Francis River Basins, Ark.	10-12					Heavy rain and flood.	More than 200,000 acres of land inundated; 20,000 families driven from home; worst flood since 1927.
Morris, Okla., and vicinity	11	4 a. m.	[1] 18		50,000	Heavy hail	Gardens and orchards severely damaged over the entire area; considerable property loss principally to buildings; path 35 miles long.
Okmulgee, Okla., and vicinity	11	4:30 p. m.	[1] 20		200,000	Severe hail	Roofs damaged; livestock killed; path 30 miles long.
Bolivar County, Miss.	11	5:45 p. m.	50	1	10,000	Tornado	11 persons injured; path short.
Pontotoc County, Miss.	11	8 p. m.	[1] 1	0	250,000	do	3 persons injured; path 8 miles long.
Warren County, Miss.	11	P. m.		0	3,000	do	Path narrow and short; other details not reported.
Milton, Tenn., vicinity of	11				5,000	Wind	2 persons injured; property damaged.
Newberry County, S. C.	12	11 a. m.			1,000	Wind	Property damaged.
Foster, Va.	12	11:15 a. m.	100	0	1,750	Tornado (incipient).	Several poultry houses blown down killing about 100 chickens.
Aiken County, S. C.	12				5,000	Wind	Buildings unroofed; trees and wires blown down.
Florence County, S. C.	12				10,000	do	Buildings unroofed; telegraph and telephone poles and lines blown down.
Kiowa, Prowers, Baca and eastern Bent, and Las Animas Counties, Colo.	12-25			6		Dust	In many places the dust lay from a few inches to more than 6 feet deep causing 100 persons to become ill; livestock perished from starvation and suffocation; schools closed temporarily in many locations as a measure of safety and many tenants deserted their ranch homes; visibility so limited that artificial light was used during mid-day; no accurate estimate of the damage to topsoil through the drought area can be made, but it will amount to millions of dollars.
Goldsboro, N. C., 10 miles northeast.	13				10,000	Tornadic wind and rain.	Woman critically injured when she was hurled from her house to the road and her home demolished; child hit by flying timber; farm house and buildings, 3 tenant houses, and 6 tobacco barns damaged to the extent of $10,000.
Colorado	15	P. m.			34,000	Wind and dust	Loose topsoil from thousands of farms in the drought-stricken area of eastern Colorado carried by winds of high velocity caused hazardous driving and flying conditions; wind velocity at Denver Municipal Airport reached 77 miles per hour; damage to property in Denver and vicinity $6,000; transient camp and powder house near Florence destroyed; Canon City loss estimated at $8,000; telephone lines down; houses damaged; windows crushed; travel made extremely dangerous through Fremont County where loss of $20,000 was reported; 20 automobiles stalled on highway near Nunn, failure of ignition systems of the stalled cars believed to have been due to static electricity generated by the terrific winds; cherry orchards in the rich agricultural section between Fort Collins and Loveland severely damaged when the freshly-plowed soil was swept away leaving the roots of trees bare; topsoil blown from fields producing winter wheat and alfalfa and in many cases fields will have to be reseeded.
Kansas, northwestern and north-central portions.	15-16	P. m.				Dust	In some northwestern counties where the storm struck in the later afternoon, visibility was reduced to zero within a few minutes and persons became lost within 100 yards of their home; trains were greatly delayed and travel by motor became exceedingly dangerous; as far east as Alton, where the storm arrived about 8 p. m., and continued for 5 hours, the air was so filled with dust street lights could not be seen across the street; many persons became lost in trying to walk home and many automobiles refused to start; persons were obliged to dampen handkerchiefs and keep them over their mouths and noses in order to breathe.
Wisconsin	16				35,000	Sleet and glaze	This storm covered the area in the eastern counties from Outagamie and Kewaunee on the north to Milwaukee on the south; heavy glaze in the vicinity of Green Bay southeast to Manitowoc caused much damage to poles and wires, otherwise damage was light.
Buffalo, N. Y., and vicinity	17	6 a. m.-2 p. m.		1	2,000	Wind	Ferry operation between Tonawanda and Grand Island suspended part of the morning; man killed in Wyoming County when he grasped a live wire that had blown down; at Lake Chautauqua strong winds heaped hundreds of tons of ice on the railroad tracks at Dewittville and New Midway.
Topeka, Kans.	20	8 a. m.-4 p. m.				Dust	This storm the most severe dust storm in the history of city; visibility reduced from 6 miles to from 220 to 550 yards and at times to slightly more than a city block; sun entirely obscured by dust clouds; artificial illumination necessary indoors; lights used on motors; travel on highways so dangerous that some roads were closed; pedestrians and motorists left tracks almost as plainly as in newly fallen snow.
Alton (near) Iowa	20		880	0	1,000	Tornado	Damage to windmill and barn.
Del Rio, Tex.	21	7:40 p. m.			325,000	Wind	Property damage $10,000; damage to empty oil tanks $315,000.
Aspermont (near) Tex.	21	P. m.	200			Tornado	2 homes and a church destroyed.

[1] Miles instead of yards.

SEVERE LOCAL STORMS, MARCH 1935—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Port Washington, Wis., 2 miles northwest.	22	4 p. m.	167–344		20,000	Tornadic winds and hail.	The Knellsville canning factory unroofed and badly damaged and their brick warehouse demolished, the debris scattered for a great distance; many small farm buildings wrecked and 2 barns totally demolished; heavy hail fell in Belgium and vicinity; hail on fields and roads reported to be 8 inches deep, in places.
Allegan, Kent, Barry, Ionia, Eaton, and Ingham Counties, Mich.	22	P. m.				Wind	Heaviest losses reported in last 2 counties named; many barns destroyed, 60 in Eaton County alone; damage throughout the entire area several hundred thousand dollars.
Wisconsin, northern portion	22–25					Flood	Flooding due to melting of heavy snow cover in northern portion of the State caused by rapidly rising waters in all streams in that section; tributaries of the Wisconsin River were so high that the ice broke up before it had chance to disintegrate and solid cakes 2 or more feet thick were carried down stream.
Omego and Kingfisher, Okla., and vicinity.	23	4 p. m.	[1] 5		70,000	Wind and hail	No building in Kingfisher City escaped damage and one-half of them required new roofs; 90 percent of windows with western exposure broken; the first growth of alfalfa entirely destroyed; losses in wheat and other grains; most fruit and shade trees completely stripped of foliage; some livestock killed.
Guthrie, Okla.	23	4:30 p. m.	[1] 5		125,000	Wind, hail, and rain.	Greenhouses completely demolished; roofs and windows of residences and stores and automobile tops badly damaged; loss to fruit trees, grain and other crops; path 8 miles long.
Bristow and Kiefer, Okla., and vicinity.	23	6:12–6:22 p. m.			113,000	Heavy hail	Ground completely covered with hail; roofs damaged; windows broken; automobile tops riddled; trees were stripped of bark; early gardens beaten down; damage at Bristow $100,000 and at Kiefer $13,000; path several miles wide and 20 miles long.
Wheatland, Okla., vicinity of.	23	7:30 p. m.			7,500	Hail	Much damage to growing crops, especially oats; property damaged; path 6 miles long.
Hazelton, Kans., 5 miles north.	23	11:30 p. m.	[1] 1		1,000	Heavy hail and rain.	Torrential rain; hailstones 5 to 6 feet deep in draws; heaviest hailstorm known to have occurred in this locality; wheat pounded into the ground; path 2 miles long.
Scott, Garfield, and Leighton, Iowa.	24		333–1,760		60,800	Tornadic wind and hail.	Buildings unroofed and barns leveled; estimated wind damage $60,000 and hail damage $800.
Western, Wash.	24			1		Wind	Man drowned when his skiff capsized in a squall; slight damage and considerable delay to transportation and communication facilities.
Charlotte, N. C., and vicinity.	25	3 p. m.	50	0	27,000	Tornado and hail	$1,000 tornado damage; $26,000 damage from wind and hail within a radius of 25 miles of the station.
Dandridge (near), Tenn.	25	3:30 p. m.	67	0	50,000	Tornado	Property damage; no details given.
Metropolis and Brookport, Ill.	25	3:40 p. m.	100	1	300,000	do	Storm began in Metropolis then lifted for about 3½ miles, striking again at Brookport; first there was lightning, then rain and hail and the funnel cloud which resembled an inverted hornet's nest; 34 persons injured, 4 seriously; in Metropolis 10 places of business, 46 homes, 7 barns or outbuildings were damaged or destroyed; in Brookport 8 places of business, 63 homes, and 39 barns or outbuildings were damaged or destroyed.
Knox County, Tenn.	25	4 p. m.	880		53,000	Wind	5 persons injured; property damaged; path 40 miles long.
Madison County, N. C.	25	5:30 p. m.	[1] 1	1	75,000	Tornado	20 persons injured, 2 seriously; 60 persons homeless; path 20 miles long; property damage $75,000.
Lumberton and Marietta, N. C.	25	P. m.		1		Electrical and wind.	Man killed by lightning; property damaged by wind.
Starr, S. C., vicinity of.	25	do			1,000	Thundersquall	Barn blown down; several small buildings unroofed.
Jackson County, Tenn.	25				5,000	Wind	Property damaged.
Murfreesboro (near) to Woodbury, Tenn.	25			2	15,000	Tornado	10 persons injured; property damaged.
Wayne County, Tenn.	25				1,000	Wind	Property damaged.
Blue Ridge, Ga., 2 miles north.	26	9 p. m.	300	0	25,000	Tornado	4 persons injured; property damaged; path 6 miles long.
Soddy (near), Tenn.	26	do	200	0	25,000	do	4 persons injured, 1 seriously; path 4 miles long; property loss $25,000.
Zurich, Mont.	26				600	Wind	An airplane was badly damaged when it was blown loose from its moorings and rolled across the field for nearly a mile.
Pearsall, Tex., and vicinity.	27	2:30 p. m.	[1] 3			Hail	Roofs and windows damaged; crops completely destroyed in spots; path 15 miles long.
Tunica County, Miss.	27	4 p. m.	100	0	1,200	Tornado	Path short; other details not given.
Eros, La.	27	4:30–5 p. m.	[1] 1			Heavy hail	Considerable damage to property and gardens; amount not estimated; path 6 miles long.
Alcorn County, Miss.	27	5 p. m.	[1] 1	0	100,000	Tornado	1 person injured; path 5 miles long.
Nashville, Tenn., vicinity of.	27				5,000	Excessive rain and hail.	3 persons injured when their car struck a tree blown across the road by the storm; streets and basements flooded; traffic halted; windows broken.
Stone's River National Park, Tenn.	28	6:15 p. m.	100	1	18,500	Tornado	Path 17 miles long; no details reported.
Welsh and Roanoke, La., vicinity of.	30	7 a. m.	[1] 2		3,000	Squall	Houses and roofs damaged; path 10 miles long.
Creola, Ala.	30	8:45 a. m.	20	0	100	Tornado (probably).	End of school house sprung about 2 inches; small frame house moved a few inches off its foundation; faint roaring heard just before and during passage of disturbance.
Orange Grove, Tex.	30	10:20 p. m.	880	1	12,800	Tornado and hail.	7 persons injured: damage to houses, barns, and windmills, $12,000; crop loss $800.
Neshoba County, Miss.	30	P. m.		0		Tornado	Path narrow; damage slight.
Deepwater, Cody, and McNair, Tex.	31	2 a. m.		1		Wind	Houses unroofed and otherwise damaged; telephone poles blown down.
Dickinson, Tex.	31	do	[1] 4			do	Several barns and outbuildings destroyed; 2 oil derricks blown over.
Elm Park (near), La.	31	5:30 a. m.	100	0	5,000	Tornado	Buildings damaged; timber destroyed; path 8 miles long.
Lawrence County, Miss.	31	7:30 p. m.	2,640	4	30,000	do	10 persons injured; details not reported.

LATE REPORTS, FEBRUARY 1935

Cleveland, Ohio, vicinity of.	24		2,640		35,000	Hail	Property damaged; path 10 miles long.

[1] Miles instead of yards.

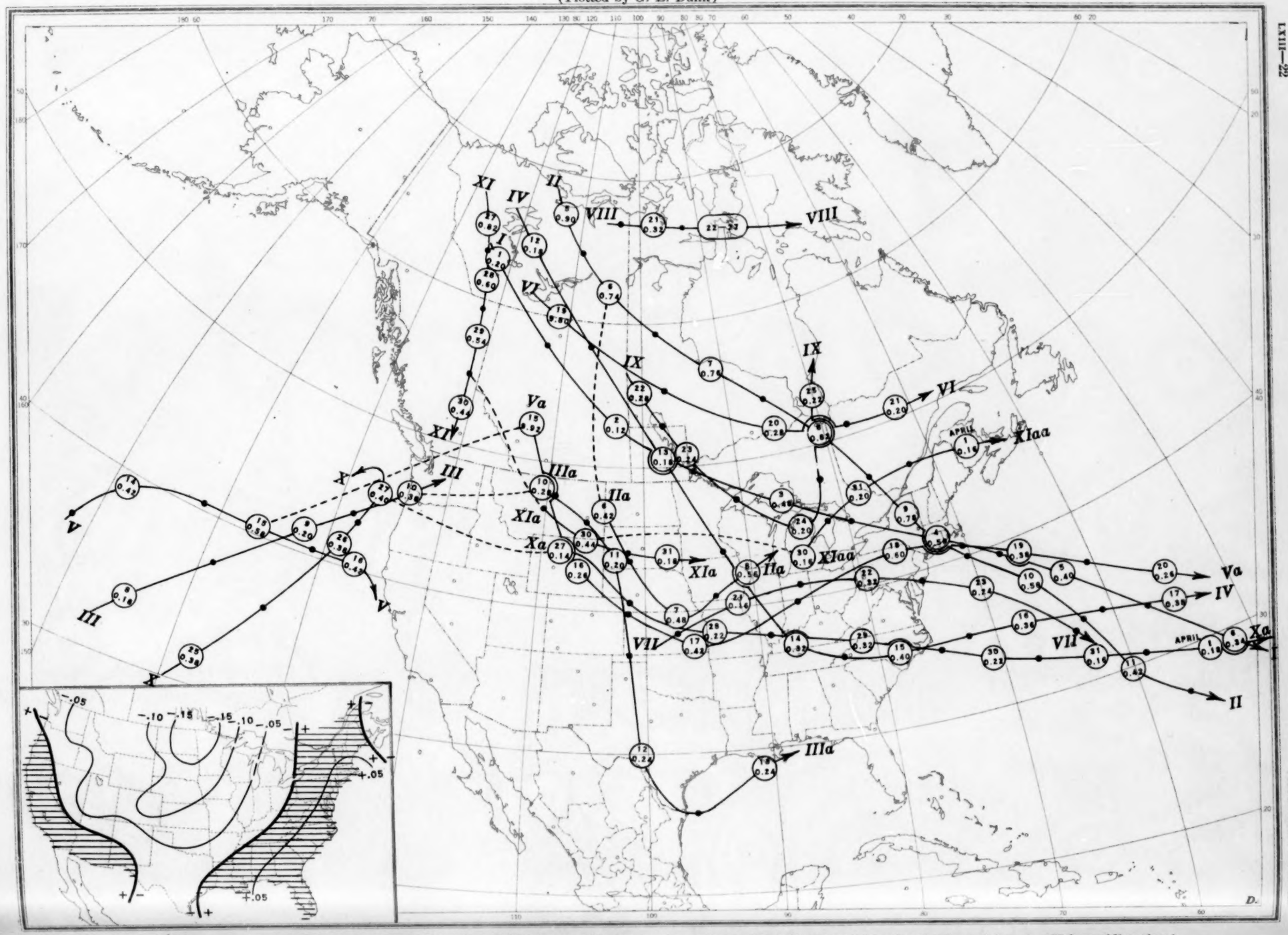
Chart I. Departure (°F.) of the Mean Temperature

Chart I. Departure (°F.) of the Mean Temperature from the Normal, March 1935

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

Chart II. Tracks of Centers of Anticyclones, March 1935. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by G. E. Dunn)

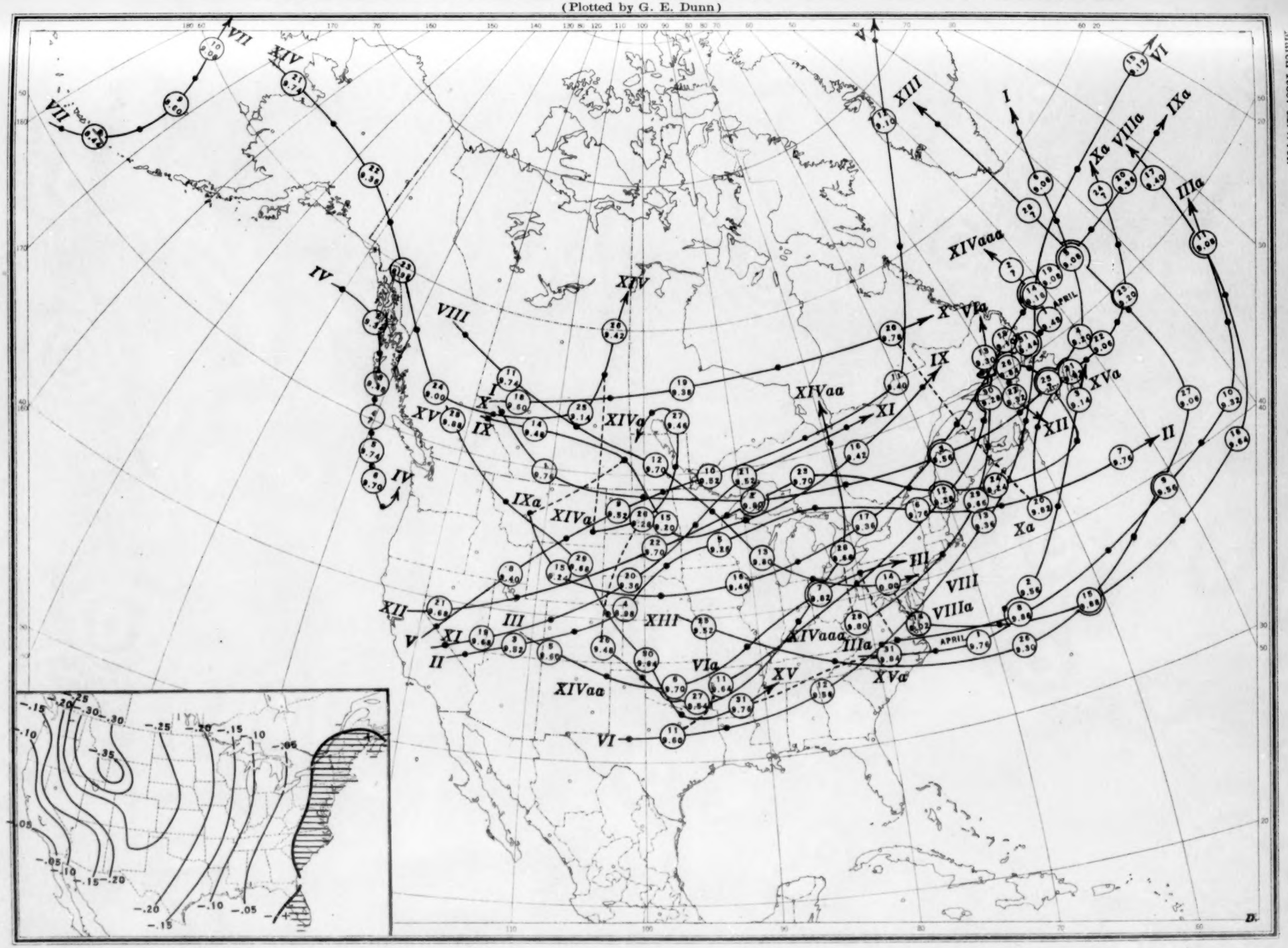


Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, March 1935. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by G. E. Dunn)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, March 1935

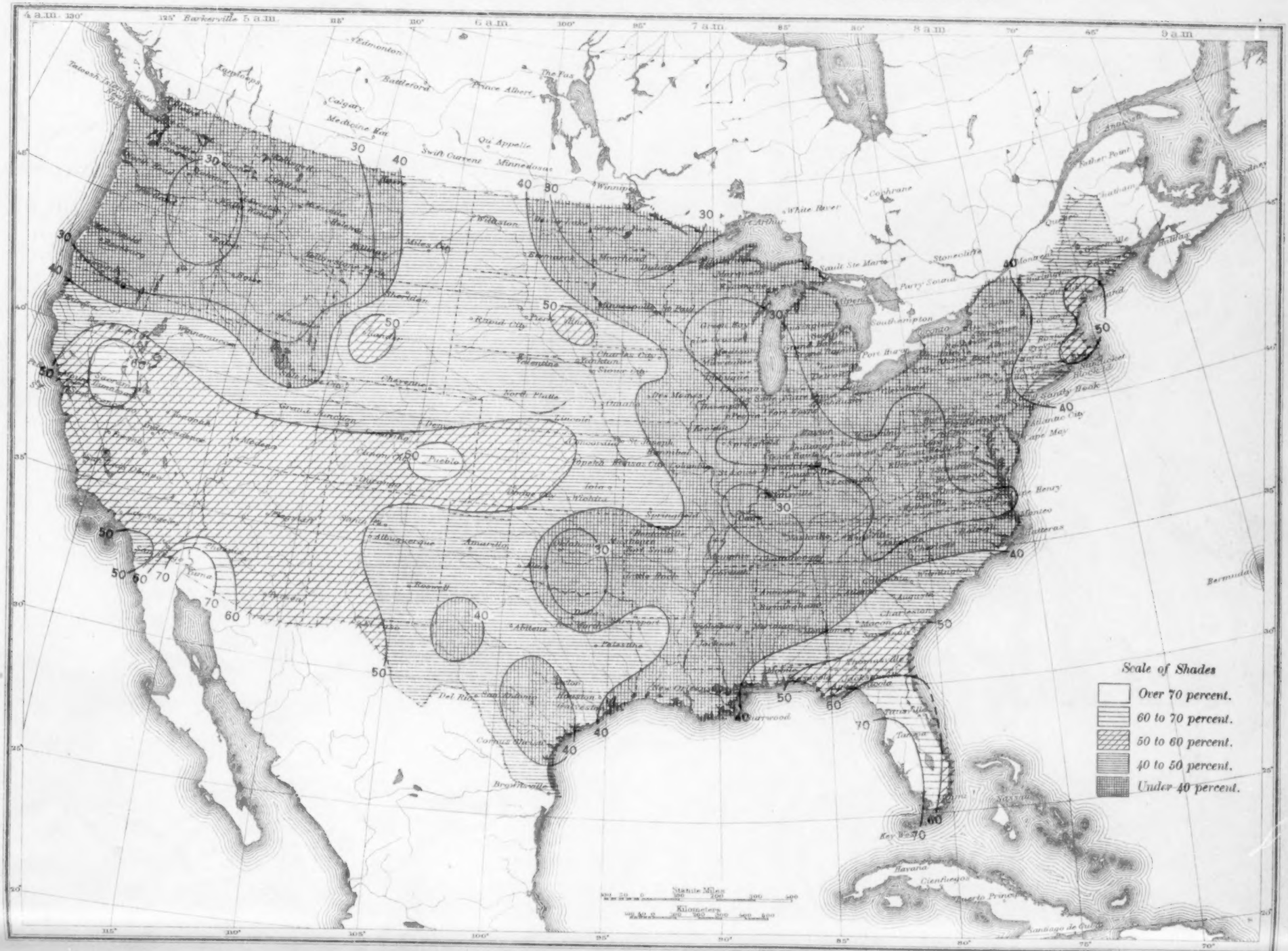


Chart V. Total Precipitation, Inches, March 1935. (Inset) Departure of Precipitation from Normal

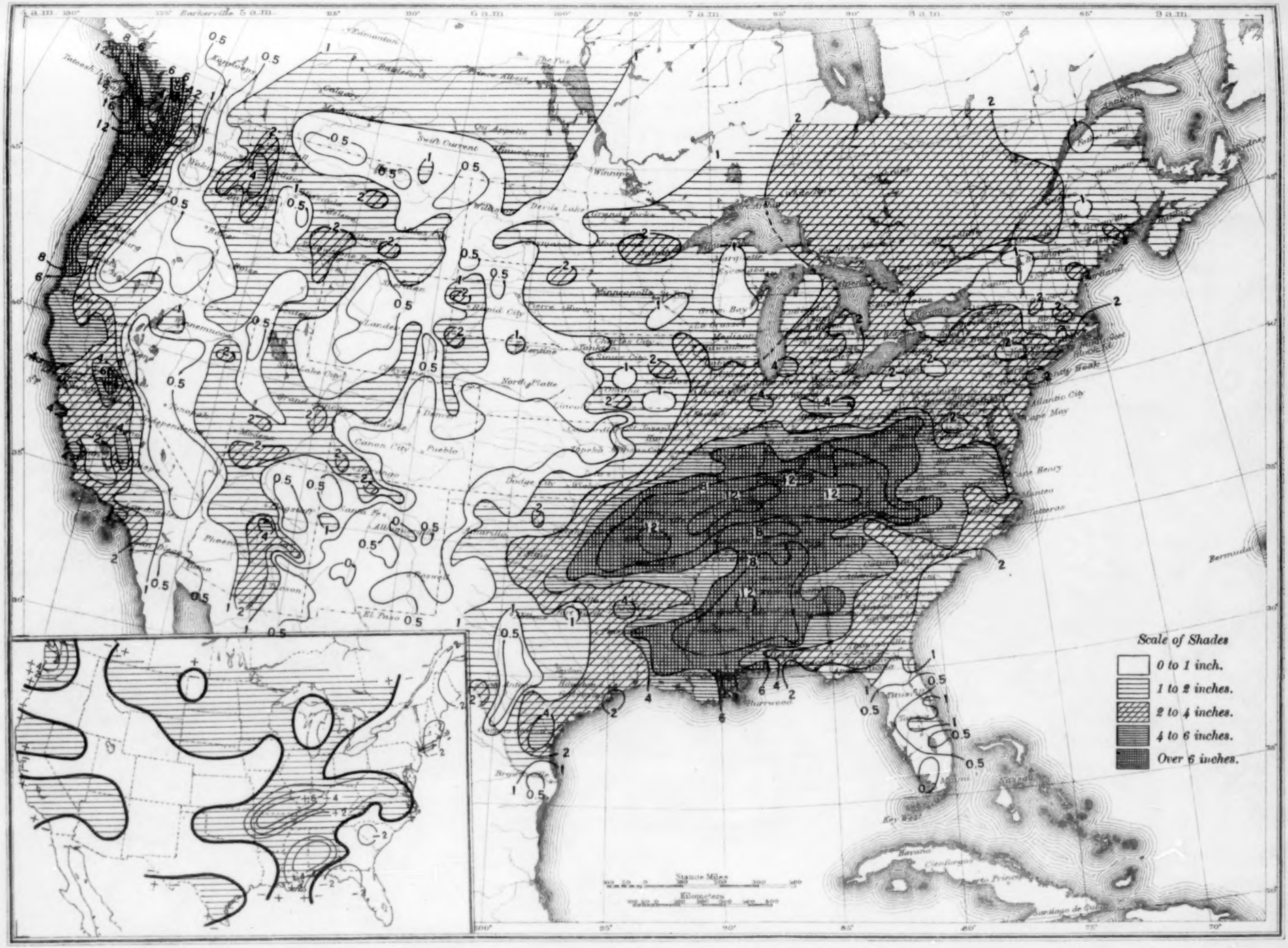


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, March 1935

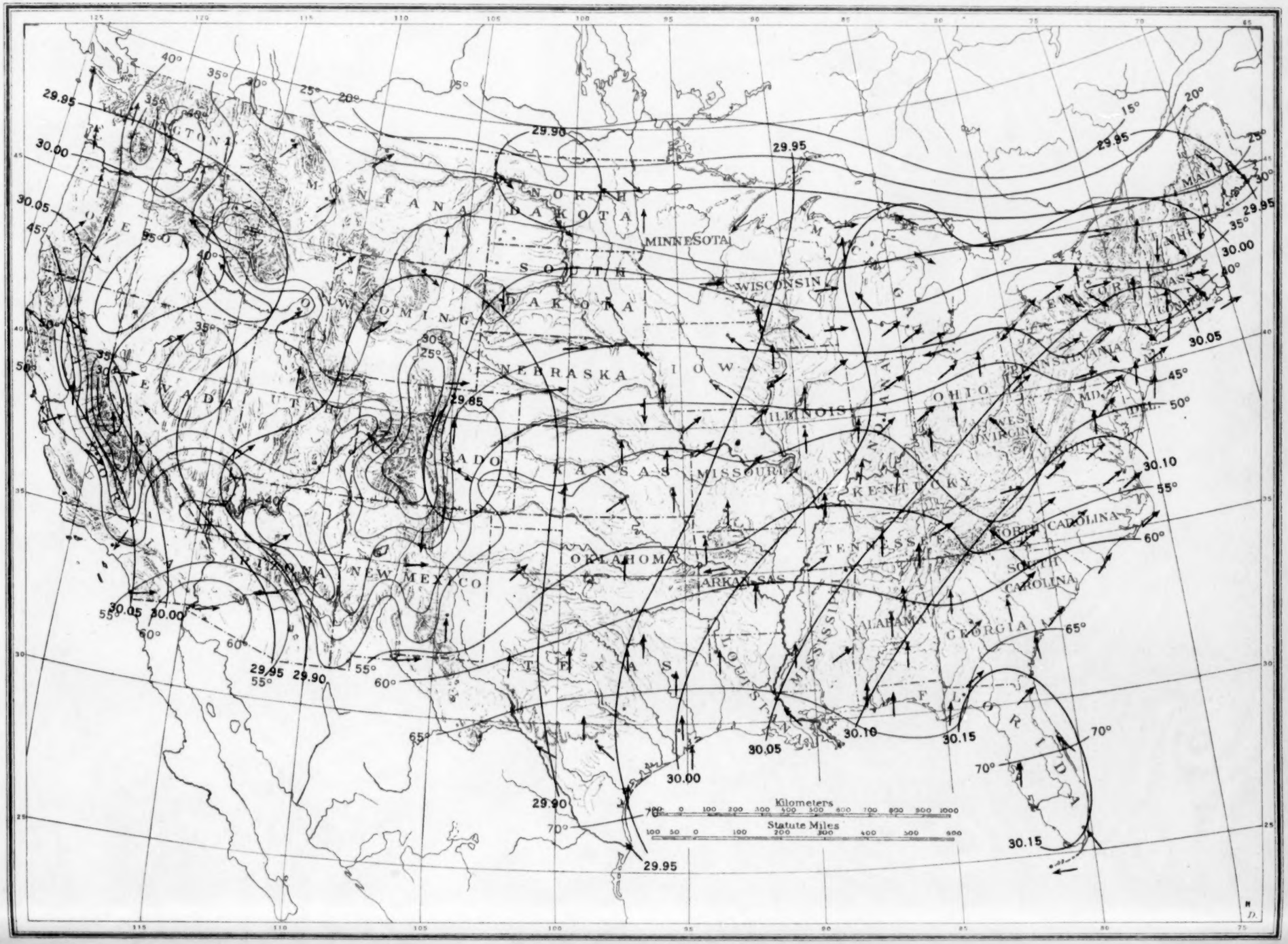


Chart VII. Wind Roses for Selected Stations, March 1935

Chart VIII. Total Snowfall, Inches, March 1935. (Inset) Depth of Snow on Ground at 8 p. m., Monday, March 25, 1935

Chart IX. Weather Map of North Atlantic Ocean, March 12, 1935

(Plotted from the Weather Bureau Northern Hemisphere Chart)

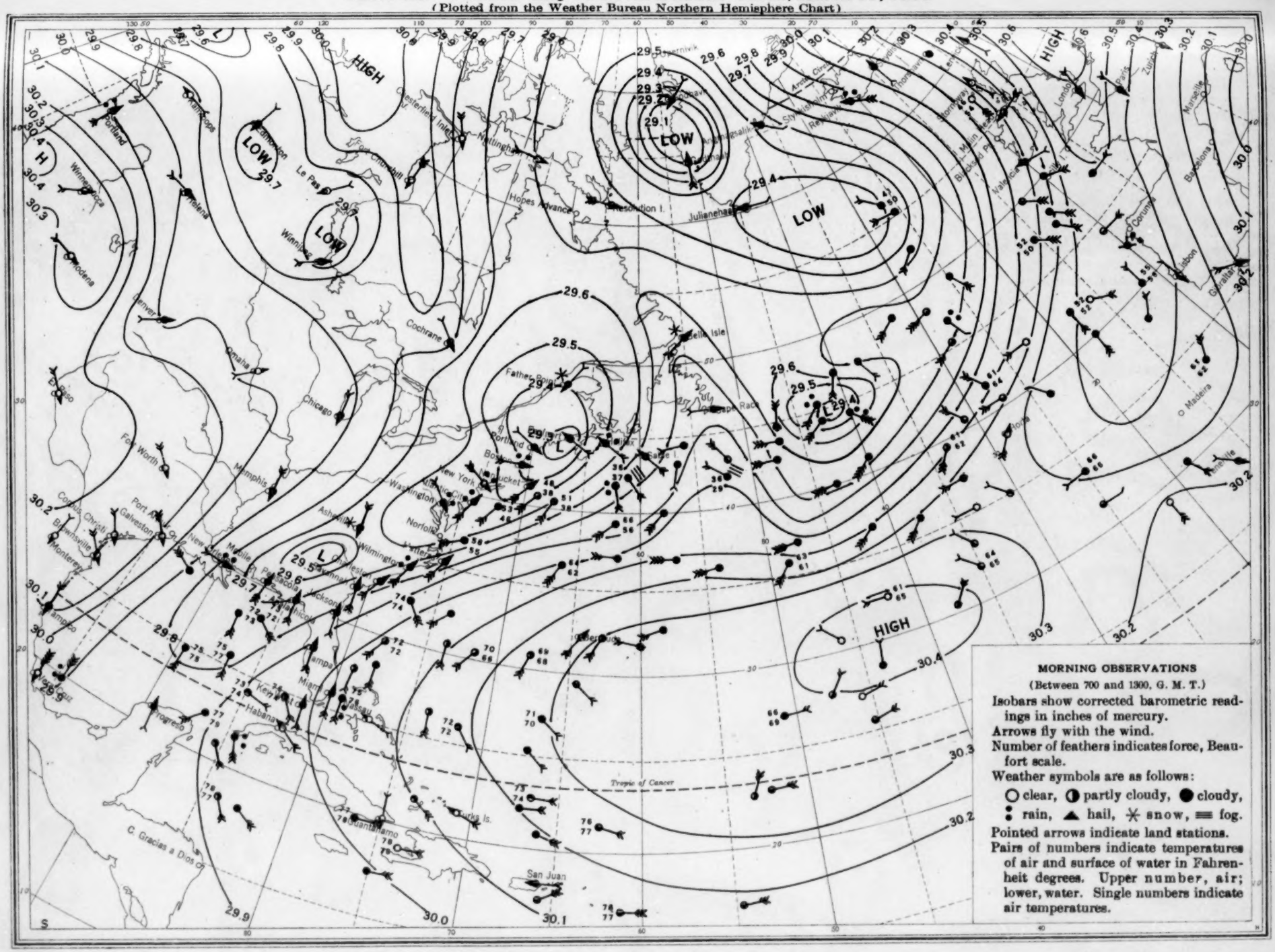
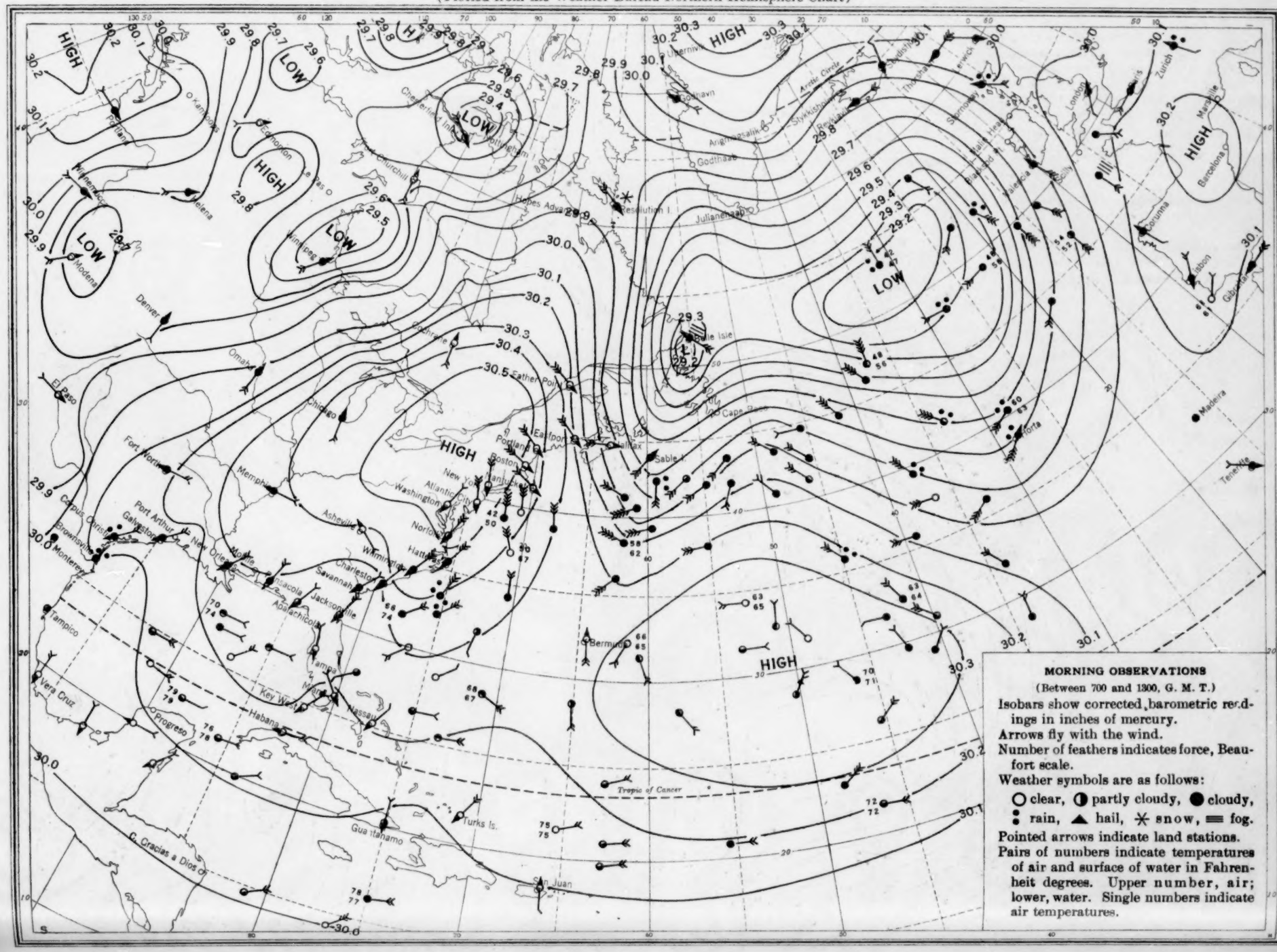

LOW
HIGH
Tropic of Cancer
MORNING OBSERVATIONS
(Between 700 and 1300, G. M. T.)
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicates force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy,
rain, hail, snow, fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

Chart X. Weather Map of North Atlantic Ocean, March 18, 1935

(Plotted from the Weather Bureau Northern Hemisphere Chart)